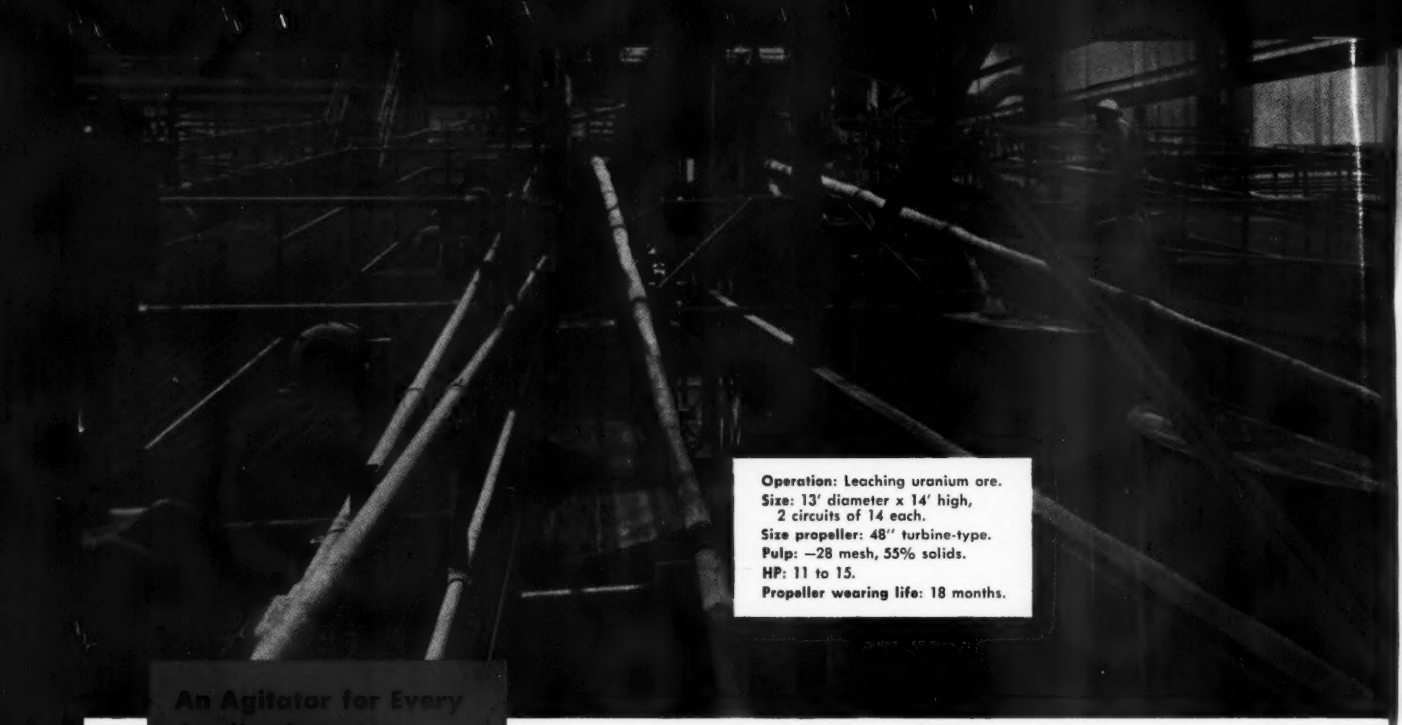
MINING CONGRESS JOURNAL

AMERICAN MINING CONGRESS

MAY 1961



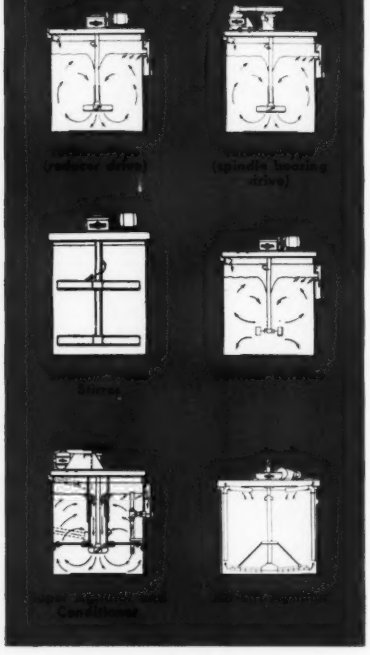
MAY



Operation: Leaching uranium ore.
Size: 13' diameter x 14' high, 2 circuits of 14 each.
Size propeller: 48" turbine-type.
Pulp: –28 mesh, 55% solids.
HP: 11 to 15.
Propeller wearing life: 18 months.

An Agitator for Every Application

Shown here are a few of the many types of Denver Agitators available to provide efficient, economical agitation in the mineral and chemical processing industries.



Kermac Nuclear Fuels Corporation Leaches –28 Mesh Sandstone Ore at 55% Solids in 28 Denver Turbine Type Agitators

Kermac Nuclear Fuels Corporation operates a 3300 ton rated capacity uranium mill in the Ambrosia Lake District north of Grants, New Mexico. The –28 mesh abrasive sandstone ore at 55% solids is acid leached using Denver Turbine Type Agitators. The 28 Denver Agitators used by Kermac Nuclear are arranged in two sections of 14 agitators each. The rubber-lined agitator tanks are 13' diameter x 14' high and use 48" Denver Turbine Type Propellers, which are also rubber-covered and have an average service life of 18 months. The first two agitators in each circuit consume 15 HP each and the remaining units, 11 HP each.

The Agitator units are heavy-duty and can be easily started up under load after shutdown without auxiliary equipment. The mill design provides step-down elevations to provide gravity flow, and the tanks are arranged so that any tank in the section can be by-passed if necessary.

This large uranium producer has found Denver Agitators perform to their complete satisfaction on this severe service. This problem of agitating coarse abrasive slurries is another example of Denver experience in handling all types of agitator problems. Equipment is specially-designed to provide proper agitation and is backed by a qualified, experienced field service organization.

Write giving details of your processing requirements for detailed recommendation.

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Opinions expressed by the authors within these pages are their own and do not necessarily represent those of the American Mining Congress.

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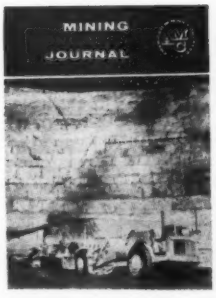
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ON OUR COVER

Crawler-mounted tractors push a twin-engine scraper as it loads ore at the Bingham mine, Utah Copper Division of Kennecott Copper Corp. For further details see pages 72 to 75.



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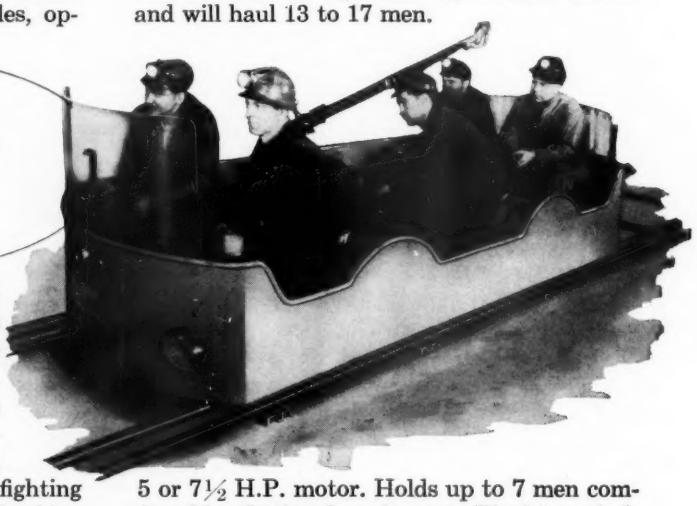
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There's no wasted motion with this self-propelled Portal Bus because it is fast on the take-off, saving manpower time for conversion into more tonnage. And it is designed for safety, with hydraulic operated running brakes plus mechanical emergency and parking brakes direct on the wheels. For severe grades, optional electric dynamic system produces braking effect from the motor for *extra* safety under all conditions. Also the split roof construction gives operator unimpeded, all directional view, while the trolley pole is always within quick reach. This bus is powered by 15 H.P. motor and will haul 13 to 17 men.

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SPECIALISTS IN COAL MINING EQUIPMENT

featured IN THIS ISSUE—and the AUTHORS

SPECIAL FEATURES OF THE GALENA MINE HOIST INSTALLATION

Obstacles to efficient hoisting at the Galena mine include a small shaft in heavy ground and great depth, a slow hoist, and a short headframe. These have been overcome with the installation of lightweight bottom-dump skips, lightweight cages, flattened-strand hoist rope with electrical conductors in the core for communications, and closed circuit television. In the future, when more production comes from bottom levels of the mine, better hoisting practices will have to be developed if improvements in capacity are to be made.



For the past ten years, Norman Visnes has been superintendent of the Galena Unit, American Smelting & Refining Co. Before joining Asarco, he was a sales engineer for four years with Joy Manufacturing Co. Visnes' earlier experience was as engineer—mine foreman at a small gold property in Montana for one year, and before that he was with the Anaconda Co. for five years at Butte.

THE SLACK COAL PROBLEM

One of the most pressing marketing problems facing the coal industry today relates to its slack or small-sized product. Modern deep mining techniques have greatly increased the percentage of slack in the mine-run product. Because of this and the changes in market, slack can no longer be considered a mere by-product but must be reckoned as a major revenue-earning factor in the over-all mine-run product. However, if it is to carry its share of the mining company's realization through price increases, slack must be upgraded—which requires costs excessive by today's standards. The author suggests that the coal industry and associated equipment manufacturers concentrate on this problem, devising a slack coal preparation cycle requiring no more than reasonable operating and maintenance costs.



Roger D. Curfman has been with Cleveland Electric Illuminating Co since 1948, serving as a fuel engineer until 1953 when he was made fuel agent. He has also worked for Commercial Testing & Engineering Co.—manager of Cleveland Laboratories; Raleigh-Wyoming Mining Co.—chemist, preparation and mining engineering; and Island Creek Coal Co.—chemist and preparation engineering.

INSTRUMENTATION AND AUTOMATION OF PLANT OPERATIONS

California Portland Cement Co. envisions development of centralized plant control of the cement-making process. Toward this goal, the company has installed instrumentation, automation, and analog control at its Mojave plant thereby improving the process by reducing the time lag between evaluation and adjustment. The operator has been freed from routine manipulations and more time is available for evaluation of long range changes that lie beyond the scope of present control systems. The report emphasizes that with centralized control it will be especially important to have competent personnel who are thoroughly grounded in theory and mechanics of automated control.

R. G. Patterson entered the cement industry in 1935 with California Portland Cement Co. where he is now vice president, manufacturing. He has worked principally in production and engineering, and in the latter was responsible for the engineering and construction, with expansions, of two cement plants. Patterson, a registered chemical engineer, State of California, is on the General Technical Committee, Portland Cement Association.

ORIENT MINE NO. 5

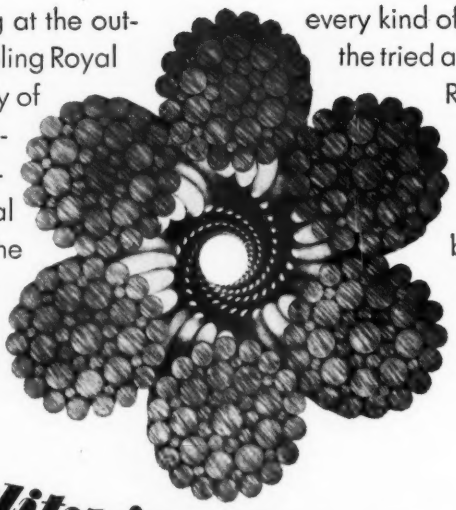
Scheduled to go into production this fall, Orient Mine No. 5 will incorporate the latest thinking in equipment and mining methods. Here is a frank account of one company's efforts to automate as far as possible, concentrate as far as practical, employ preparation facilities as up to date as the future market indicates, and hold manpower requirements to a minimum. Full coverage is given to the economics behind the opening of the property, the amount of exploration and pre-engineering that was involved and the reasons for choice of equipment and facilities.

(CONTINUED ON PAGE 5)

Thomas L. Garwood has designed preparation plant and mining equipment for the past 35 years, including dedusting equipment used extensively in production of stoker coal in its heyday. Prior to his present position as chief engineer, Freeman Coal Mining Corp., he served Chicago, Wilmington & Franklin Coal Co. as an engineer, working on ventilation and safety.



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You get a lot of work out of it

(CONTINUED FROM PAGE 3)

IN THIS ISSUE—and the AUTHORS

ECONOMICS OF LARGE VERSUS SMALL HAULAGE UNITS

Should a fully depreciated fleet of 20-ton trucks be retired and larger trucks purchased to replace them? This is only one of many important problems that Central Ohio Coal Co. has faced over the years in its efforts to develop an efficient method of transportation. Of particular interest is the fact that larger units, 40 tons and over, have proven to be the most economical for this company.

From 1937 to 1952 E. F. Eckhardt worked with the coal division of Eastern Gas & Fuel Associates as transitman, construction engineer, mining engineer and mine superintendent, and from 1952 to 1957 with Central Appalachian Coal Co. as mine superintendent. Since 1957 he has been associated with American Electric Power Service Corp. as manager of coal mining of the subsidiary companies of Central Ohio Coal Co., Central Appalachian Coal Co. and Central Coal Co.



LARGE COMPANY EXPLORATION

If a mining company is to stay in business over the years, it must constantly search for new ore deposits. A large metal mining company does not generally require immediate return on its exploration investments and can therefore undertake costly long range programs that are beyond the reach of the small company, and can assume greater risks if the potential target is sufficiently large. These programs must take into consideration, among other things, future metal supply, demand, and value in addition to the economic and political climate in a given country over the long term.

Glenn C. Waterman is chief geologist of The Anaconda Co. (Canada) Ltd. He has served The Anaconda Co. in Chile, British Guiana, Canada, the Caribbean, and Western United States. Before joining Anaconda in 1947 as chief geologist, exploration in British Guiana, he was chief geologist of Idaho Maryland Mines for two years. He was a geologist with U. S. Smelting Refining and Mining Co. from 1942 to 1945, having earlier spent about eight years in California gold mines.



HUMAN ENGINEERING IN SAFETY

One definition of the term "human engineering" is the adaption of human beings to the operation of machines. Therefore, this field deals primarily with a thorough knowledge of human behavior, taking into consideration man's limitations, as well as his instinctive reaction to certain circumstances. While human engineering is not an exact science, it is possible to apply it to improving conditions and in selecting people with the proper aptitude and abilities to do a safer job more efficiently. The author considers such ideas as standardizing control levers to facilitate the training of machine operators, and remote control to increase safety.

C. G. Evans, personnel manager, North American Coal Corp., entered the coal industry in 1922 and, except for time out to attend the University of Cincinnati and Western Reserve University Graduate School for Industrial Psychology, he has been associated with the industry ever since. He has a vast working knowledge of mines in North Dakota, Ohio, West Virginia, and Pennsylvania.



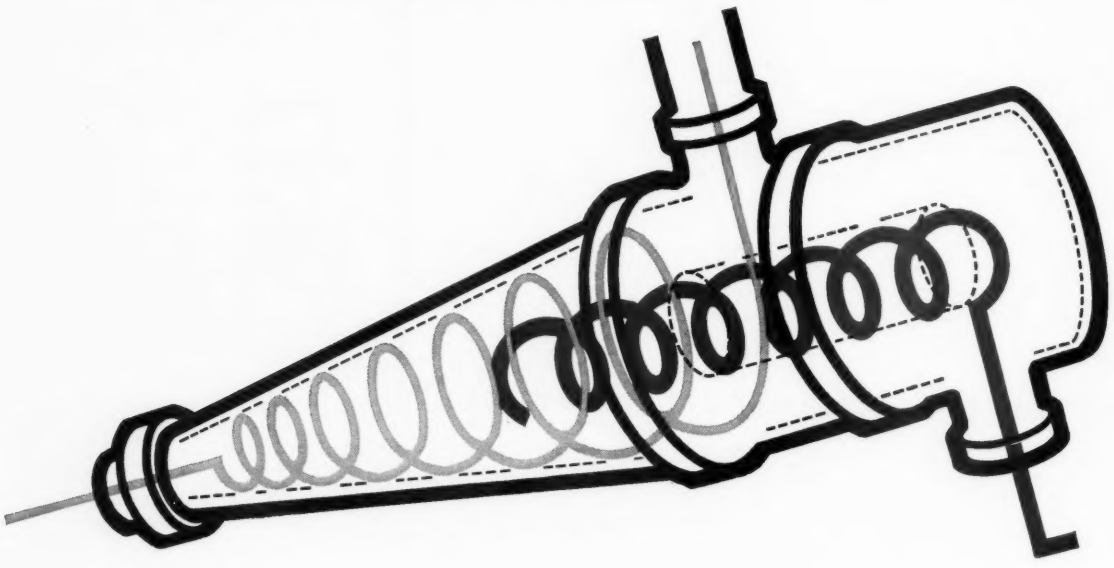
METHODS OF OVERBURDEN STRIPPING

The ability to remove overburden economically is the key to successful open pit mining. Whether to use tractors and scrapers, shovels and trucks, draglines, or more specialized equipment—such as bucket wheel excavators or belt conveyor systems—is dictated by the volume to be moved and the operating conditions. The article discusses basic factors to be considered in adopting new equipment and methods now available to handle almost any conceivable earthmoving job. As stripping ratios increase, more efficient equipment will be needed.

J. V. Otter has had a long career in civil engineering and heavy construction. Since 1952, he has been special services engineer with Morrison-Knudsen Co., Inc., having first joined M-K in 1940, later leaving the company to establish a consulting engineer office. He has served as a consultant to several agencies of the Federal Government and also includes in his experience four years of engineering teaching.



DUTCH STATE MINES
HEAVY MEDIUM *Cyclone* WASHER



1960 OPENED A NEW ERA
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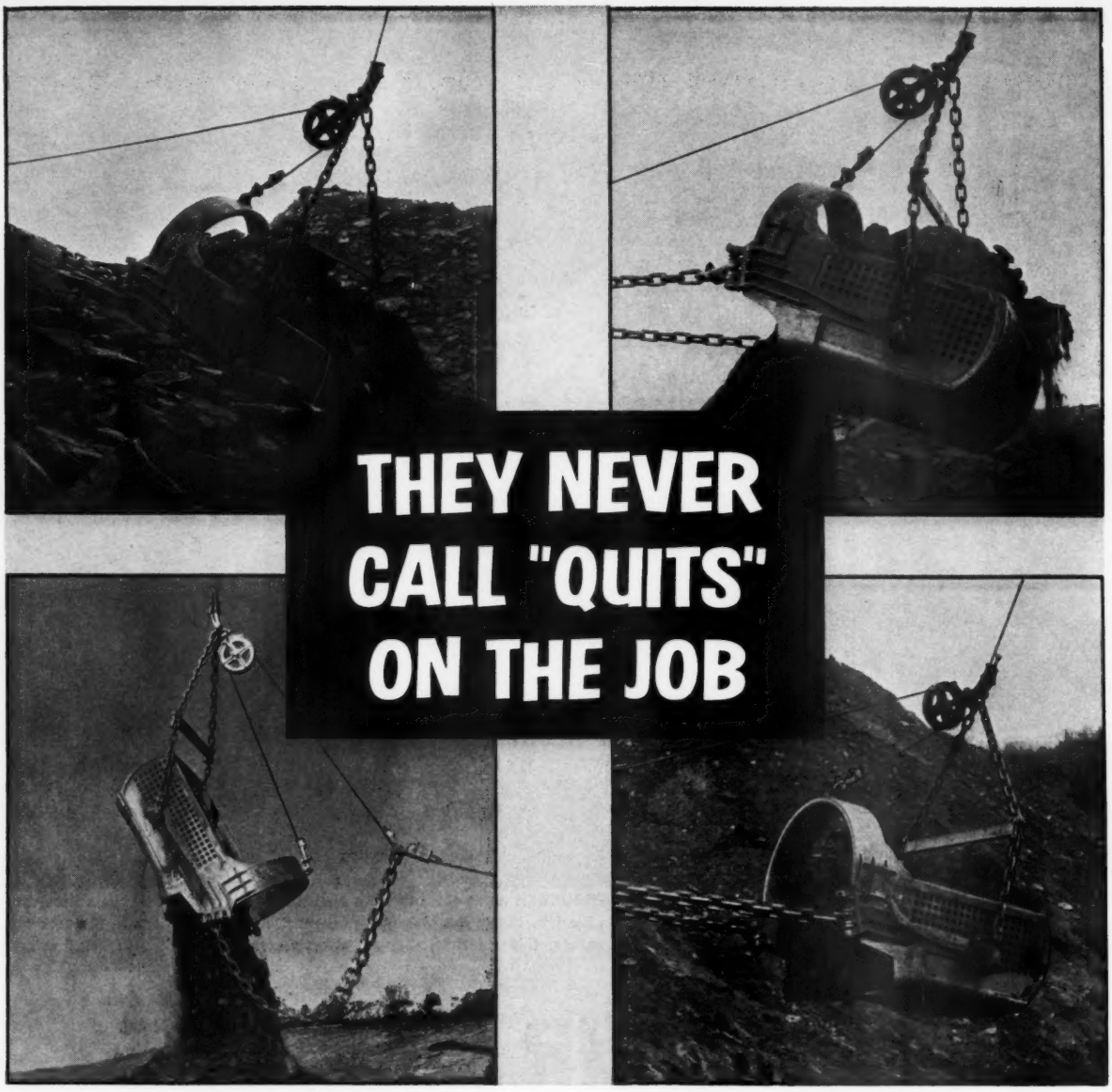
With such a strict rule of thumb, it's no wonder Mack superiority made itself known early. In this rough and rugged hauling business, Macks carved out a permanent niche for themselves by their ability to continually deliver top-notch performance.

Now the new 45-ton six-wheel Mack M Model, made for mining with mining-duty components, is giving new meaning to durability and trouble-free performance.

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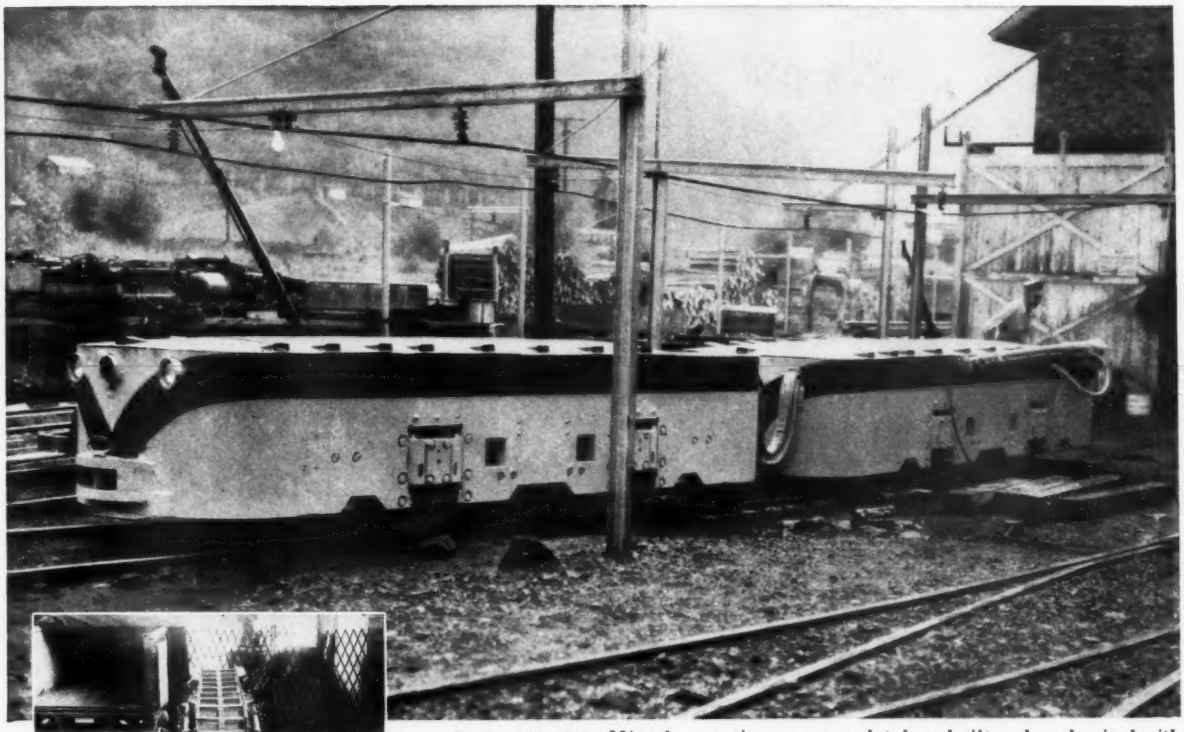
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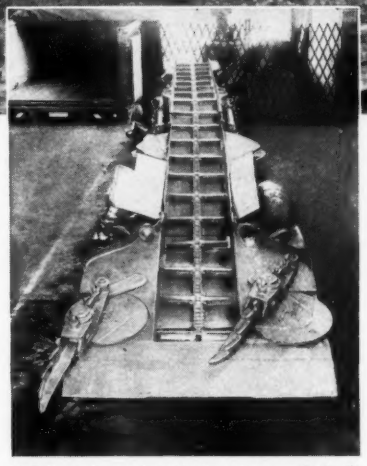
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National completely dismantles, inspects, rebuilds and tests. The work is done by specialists. For fast service, contact our nearest plant or your National field engineer.

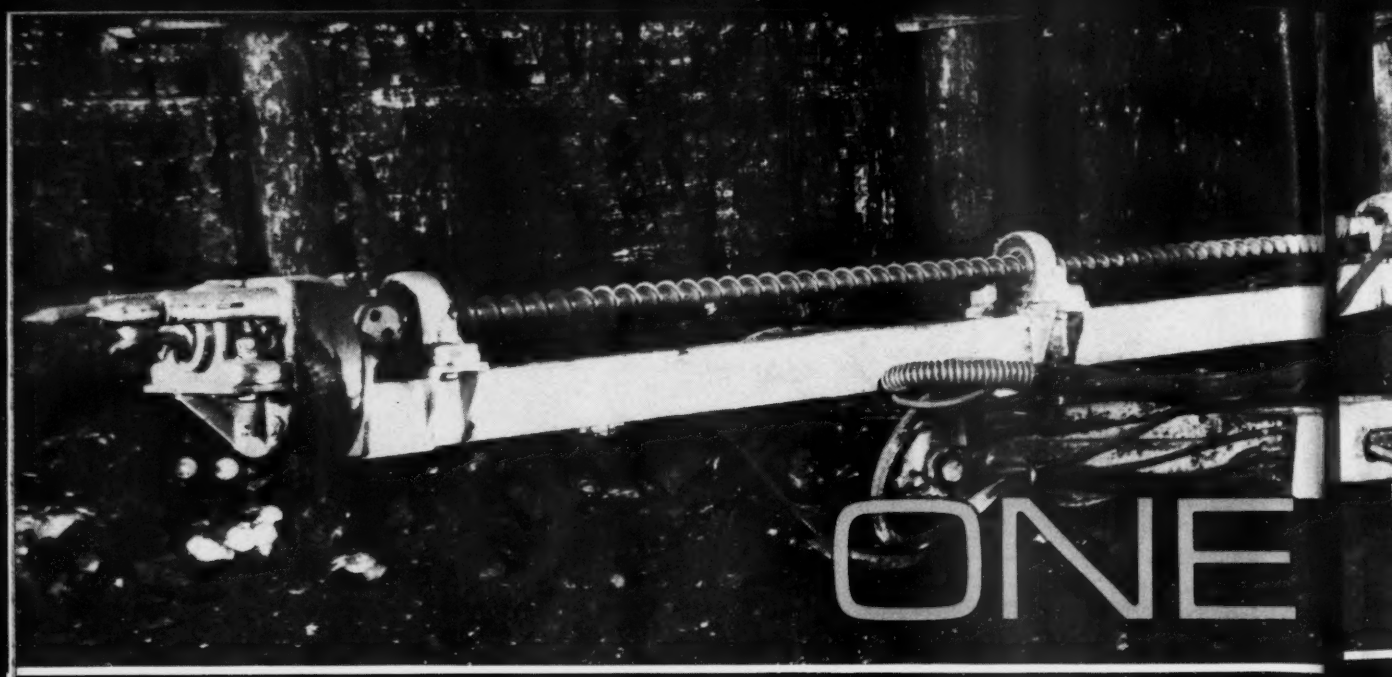
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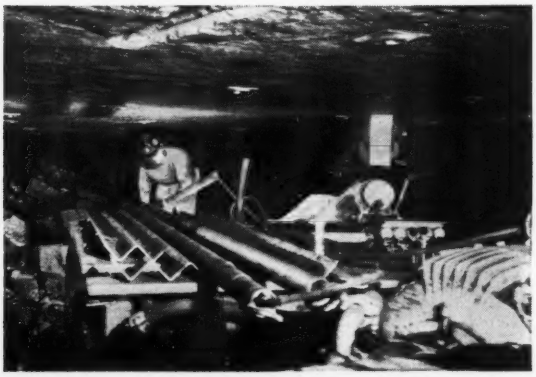
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ELECTRICAL ENGINEERS•MANUFACTURERS OF ELECTRICAL COILS, INSULATION, LIFTING MAGNETS•REDESIGNING AND REPAIRING OF ROTATING ELECTRICAL MACHINES





Single unit drilling, multiple shooting machine

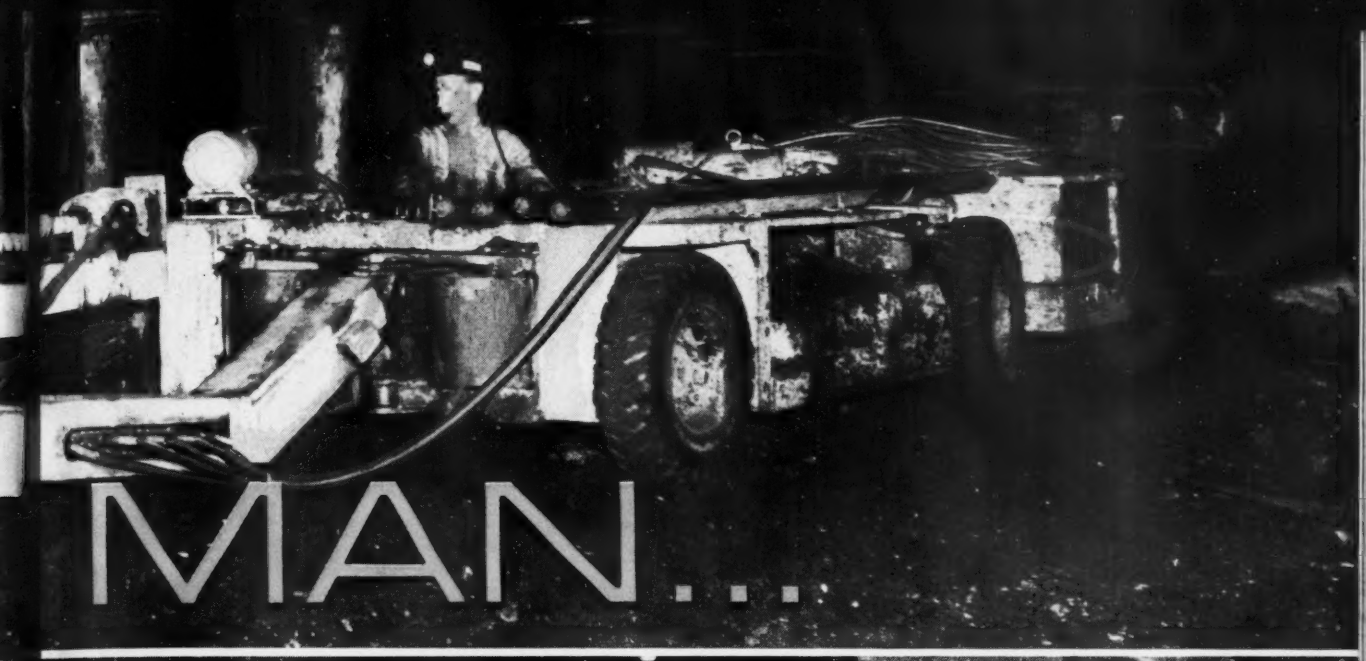


This is a "standard" cycle established in a West Virginia coal mine.

Tramming (200 feet average)	2.00 minutes
Drilling	4.10 minutes
Loading Holes with Airdox Tubes	2.00 minutes
Walk to Blowdown Valve and Return	1.32 minutes
Shooting	1.50 minutes
Removing Tubes From Holes, Loading on Machine	2.00 minutes
Total	12.92 minutes

The Long-Airdox mobile drilling and multiple shooting machine makes it possible for *one man* to drill and shoot the face quickly and economically.

It is equipped with racks for carrying tubes, high





offers fast cycle for high capacity mining systems

pressure hose, and sequence valves. Operator drills holes, inserts tubes, and shoots them in proper sequence in a single operation.

New Long-Airdox developments—the mobile coal drilling and multiple shooting machine, lighter weight automatic discharge tubes, sequence shooting of any number of holes, and others—force revision of former ideas concerning air shooting. Long-Airdox Mobile Multiple Shooting also gives you these plus benefits.

- Faster cycles—no waiting for smoke to clear.
- Better loadability—coal is heaved outward for easier, faster loading.
- Full undercut depth realized—square faces and ribs—more coal per cut.
- Especially suited to deeper cuts.
- Low cost—based on clean coal only.
- Better sizing for higher realization and less expensive cleaning.
- Coal has firmer structure—better size stability on the way to market.
- Safety.

For complete details on Mobile Multiple Shooting, and for information on drilling machines for all applications, write Long-Airdox, Oak Hill, West Virginia.

LONG-AIRDOX



This 21000-powered Bucyrus-Erie dragline is swinging a 3-yd bucket on a stripping operation south of Seagoville, Texas.



H. GLENN BUTLER



CLARK FINDLEY

"20% more production on 40% less fuel with our Allis-Chalmers 21000 diesel"

. . . says Butler-Findley Co.

Repowering a Bucyrus-Erie 54-B dragline with an Allis-Chalmers 21000 diesel boosted stripping operations 20 percent for Butler-Findley Co., Dallas, according to Clark Findley, superintendent and production manager. "This engine has given a good old machine new life and stamina," said Mr. Findley.

H. Glenn Butler adds, "Not only that, we are realizing fuel savings of over 40 percent! The 21000 uses less than 5 gal. per hour compared with over 8 gal. for engines in our other machines of the same capacity. We get more work done with much less operation expense, which means dollars to us."

If you want to boost production and save money doing it, talk to your dealer about powering with a modern Allis-Chalmers diesel. Allis-Chalmers, Milwaukee 1, Wisconsin. BC-35

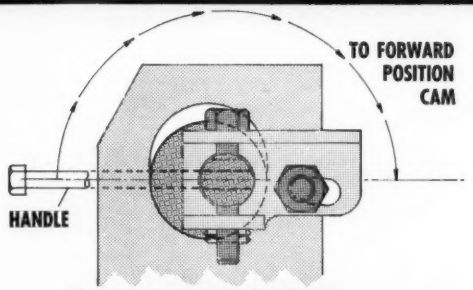
ALLIS-CHALMERS

POWER **FOR A GROWING WORLD**

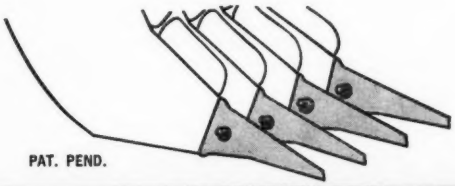
H&L *Teeth that really dig!*

New CAM ASSEMBLY

ADJUSTS POINT TO MOST EFFECTIVE RIPPING ANGLE



CAM LOCK DETAIL
CLEVIS REMOVED



Now make the precise adjustments that are necessary for effective economical ripping . . .

ADJUST POINT ANGLE TO MATERIAL (TYPE AND CONDITION)

- ADD LONGER WEAR LIFE
- REDUCE RIPPING COSTS
- INCREASE RIPPING PRODUCTION

THE NEW ALL FORGED HIGH ALLOY STEEL NO. 36 RIPPER POINT



A ONE-PIECE

FORGING

OF NEWLY FORMULATED SUPER STEEL WITH UNIFORM GRAIN FLOW AND CONSTANT HARDNESS FROM CORE THROUGHOUT POINT—GIVING UNBELIEVABLE WEAR RESISTANT ENDURANCE

SEE THESE AND MANY OTHER NEW ITEMS AT THE COAL SHOW!

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SEE YOUR LOCAL H&L DEALER

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1540 SOUTH GREENWOOD AVE.
MONTEBELLO, CALIFORNIA

SPECIALISTS SPECIALIZING IN THE MANUFACTURE OF BETTER DIGGING POINTS FOR OVER 30 YEARS

Union Wire Rope

Tough-job "champs"--Union Wire Ropes and Slings



"Real Gone" from Beatings on the Drum

Even under normal operating conditions, drum wear gives wire rope severe punishment. This wear concentrates at the cross-over points and at the flange. Excessive drum crushing results from operating on small drums, excessive loading and poor winding. Smooth drums are not recommended. Here are typical "drum beatings"; cross-over wear; cross-over crushing on drum; drum crushing from poor winding; drum-crushing from small drum.

Although drum wear cannot be eliminated, its effects can be greatly reduced. Under properly engineered procedures, two and three times the service can be obtained from the same line by improving drum conditions. Union Wire Rope Engineers will help you with this problem.





On the "Blink" from a Kink

This open kink resulted from mishandling of rope. Guard against kinks by proper winding on the drum. Never pull a loop smaller. Always enlarge it, then straighten out the rope.

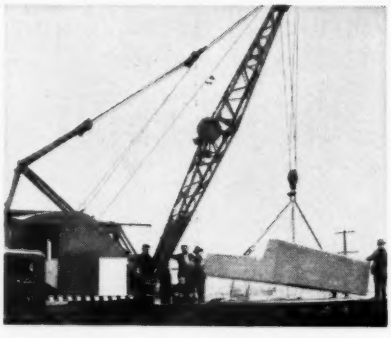
Each Union Tuffy is Engineered to Meet a Different Tough Job



Tuffy Scraper Rope

Flexible enough to take sharp bends; stiff enough to resist looping and kinking when slack; highly resistant to the shock of load impact — that's Tuffy balanced construction. Mount a reel on your scraper—save wasting sound rope.





Tuffy Slings and Hoist Lines

Slings are a patented, 9-part machine-braided wire fabric that is next to impossible to knot or kink. Hoist lines have built-in strength, toughness, flexibility. Balanced—a top-performing team for handling every type of material. In addition to Tuffy, Union Wire Rope furnishes a complete line of slings.





Tuffy Dozer Rope

Mounts right on your dozer in a 150′ reel. When rope shows wear, just feed through enough to replace the damaged part. Saves rope, gives you a bonus of extra service. Also available in 300′ and 500′ reels.

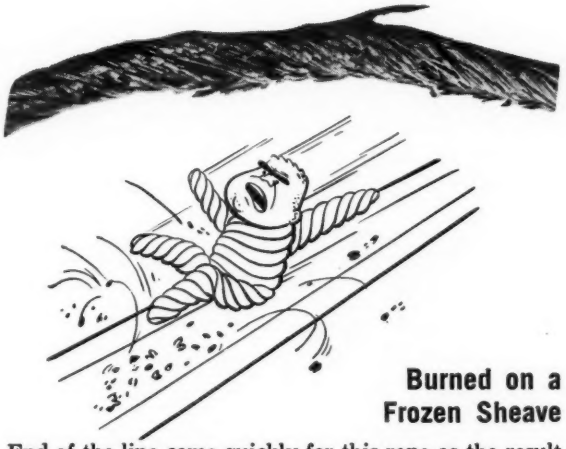


Look to the Union Wire Rope Organization for "Right Rope" Service. Union has more than 1600 standard constructions, *plus* the special Tuffy family of wire ropes and slings tailored to exacting special needs. For many years people with special wire rope needs have been coming to Union for help. That's the way the Tuffy family grows. Our research laboratory is at your service. If we don't already have it, we'll design and fabricate just the rope or sling you need. And you'll be sure of Union strength, Union flexibility, Union job-tested quality. Call your Union distributor—see the phone book Yellow Pages.

Tuffy® Tips

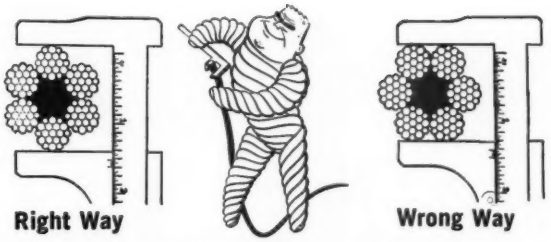
New steels are born at Armco

keep the title longer with proper handling.



Burned on a Frozen Sheave

End of the line came quickly for this rope as the result of operating over a sheave that did not turn. Note the exceptionally heavy abrasion on one side of the rope. Sheaves should be checked thoroughly and often.



How to Measure Rope Diameter

To get the most service, efficiency and safety out of wire rope operation, rope and sheaves must be precisely fitted to each other. There's only one right way to measure rope diameter: use machinist's calipers and be sure to measure the *widest diameter.*

A slight shift of the rope in the calipers, as shown above, will give you a misreading which would result in ordering an undersize rope. Note that the measurement at right shows 1/8" under correct diameter. Be sure to double-check every time!



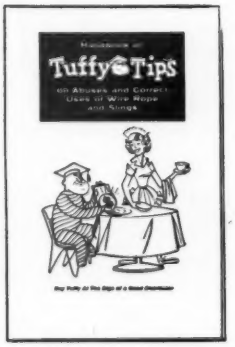
Tuffy Dragline Rope

High abrasive resistance and super flexibility. Gives long service, dependable action in handling any material—wet or dry dirt, sand, gravel, rock, minerals. Rides smoothly on grooves—hugs the drum when casting for full load.



Union Wire Rope Handbook of TUFFY TIPS...Free!

The "Tuffy Tips" shown here are quoted right out of Union's handbook. In it there are dozens of other priceless hints on the correct use of wire rope. The common abuses and how to avoid them. How to save costly injuries. Maintenance tips. The proper fittings and how to apply them. Recommended sizes. Many other facts and suggestions that will cut down your rope costs and help you get out of wire rope the full service we build into it. No charge. Write Union Wire Rope, Armco Steel Corporation, 2144 Manchester Ave., Kansas City 26, Missouri.



2-61

ARMCO Union Wire Rope

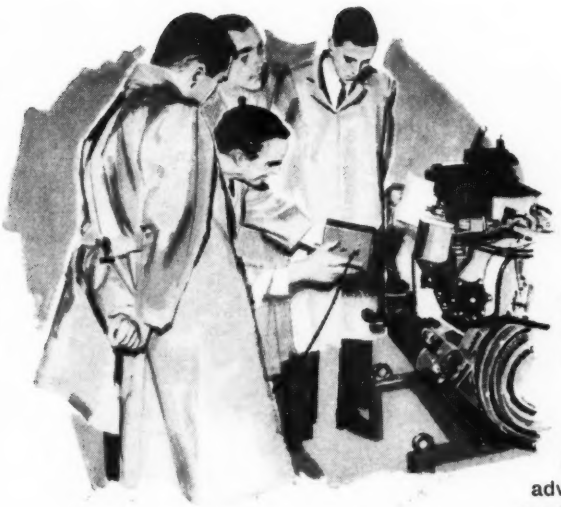


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A sales organization especially trained to serve industrial and fleet customers . . . 74 District Offices and 13 Regional Offices . . . 4,100 warehouses and distribution points . . . 12 refineries . . . more than 2,000 products to serve you . . . this is American Oil Company.







The American Oil Company representative who calls on you receives special training in servicing industrial and fleet customers at our Sales Engineering School. His training begins with a concentrated course in petroleum product quality and application. According to a planned schedule, he returns for an advanced course and then again for post-graduate work. From our Marketing Technical Service Department, your American Oil representative draws assistance, when needed, from specialists who are recognized authorities in their fields. These specialists may be called in at any time to work with you on your lubrication problems. More than a thousand research scientists and technicians at our research laboratory support the effort of our representative to serve you. Their mission: To help your American Oil representative help you lower your maintenance costs and stretch your maintenance dollars. Learn more about American Oil, its men, its service, its products.





AMERICAN

AMERICAN OIL COMPANY

910 S. Michigan Ave., Chicago 80, Ill.



Production lost by accidents like this can cost more than the original cable. The exceptional crush-resistance of Anaconda flat shuttle-car cable repays your cable investment many times over by assuring minimum downtime.

Even if this should happen, flat Anaconda shuttle-car cable stays on the job

When a machine runs over Anaconda *flat* A-C or D-C shuttle-car cable, its weight is spread evenly over all the conductors, instead of being concentrated at a few points, as it is with round cable. The conductors won't shift under the jacket, because the insulation is shaped to fit the jacket exactly—D-shaped on the outside conductors and square on the center conductors.

The flat shape is safer for personnel, too, because it won't roll when stepped upon.

Inside, nylon breaker strips separate the insulated conductors, for extra crush resistance and less chance of conductor-to-conductor shorts. Tough Neoprene insulation, color-coded for easy identification, reduces conductor cutting action to a minimum. A specially compounded Neoprene jacket, which has proved its abrasion resistance through years of service, is reinforced by a rugged nylon web. For A-C service special grounding conductor construction lets you use ground trip relay systems.

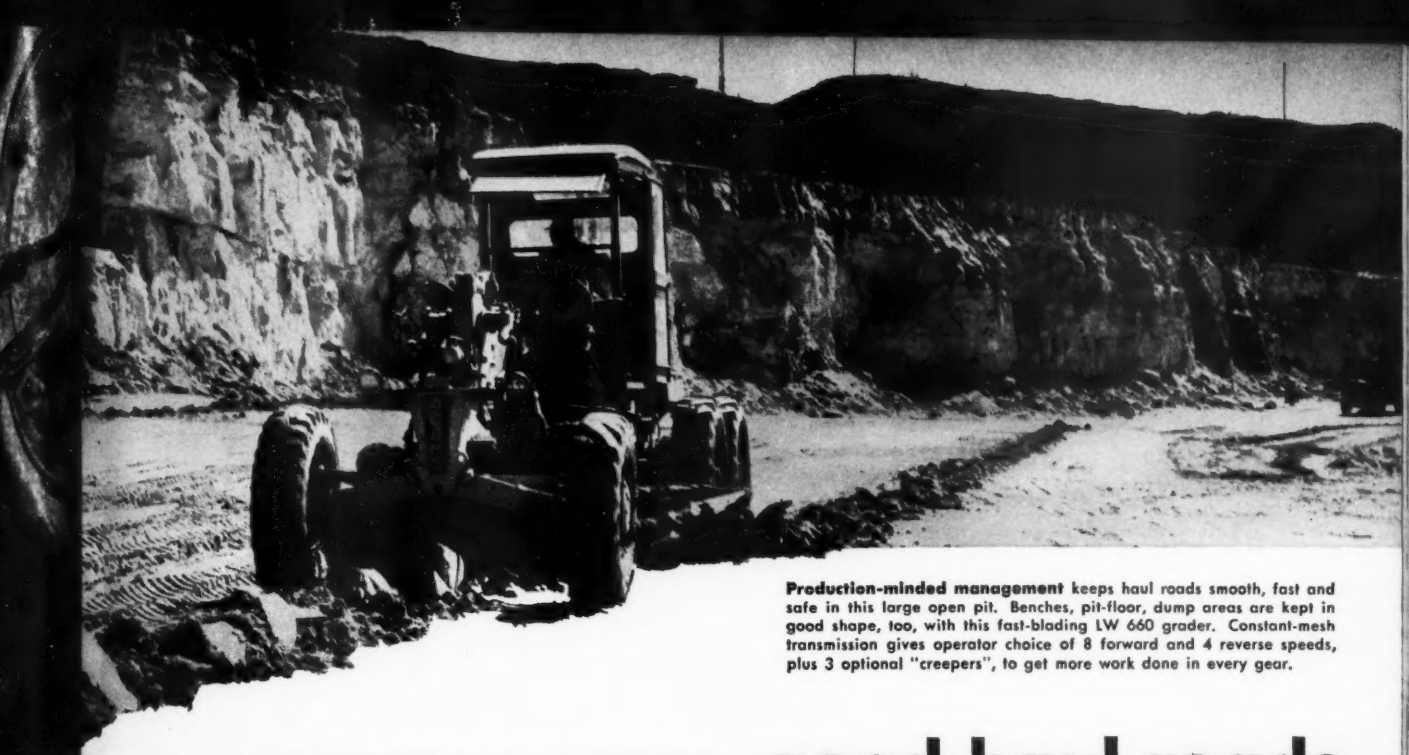
For more information about Anaconda flat shuttle-car cable for A-C or D-C systems, contact the Anaconda Wire & Cable Company, 25 Broadway, New York 4, New York, Department EFL-1-MCJ.

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ASK THE MAN FROM

ANACONDA®

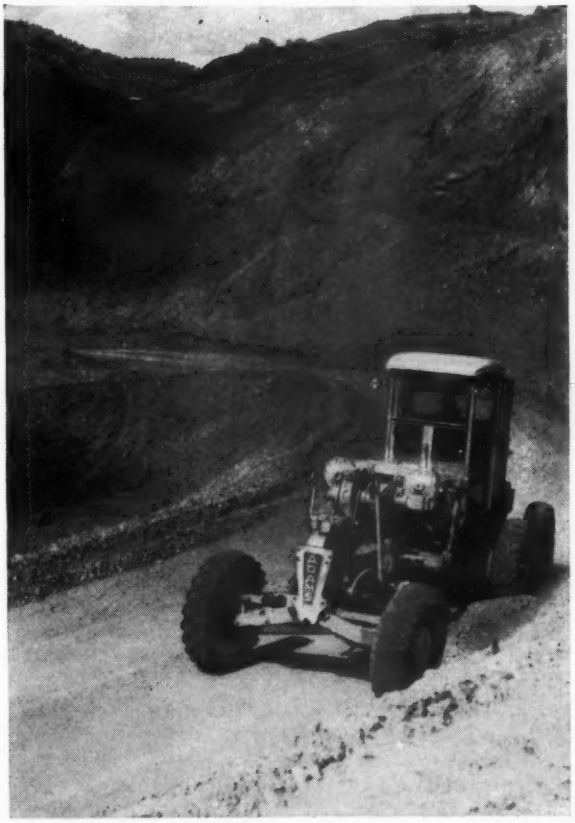
FOR FLAT SHUTTLE-CAR CABLE



Production-minded management keeps haul roads smooth, fast and safe in this large open pit. Benches, pit-floor, dump areas are kept in good shape, too, with this fast-blading LW 660 grader. Constant-mesh transmission gives operator choice of 8 forward and 4 reverse speeds, plus 3 optional "creepers", to get more work done in every gear.

YOUR BEST PRODUCTION-BOOSTER: good haul roads

Actually, it doesn't "cost" to maintain smooth, safe haul roads. *It pays* — in higher average hauling speeds/bigger daily tonnages/lower truck-repair costs. *Quickest* way to patrol your roads, maintain smooth pit-floor and dump areas, is through the *extra speed* you get in LeTourneau-Westinghouse graders. For example, with any straight-shift LW you get 5 to 9 *more* full-power gear ratios than with any other make in its size class. You work 1 to 7 mph *faster*... complete up to 28% more blade-work per day! Or, use a POWER-*Flow*® 550 or 660, and you get infinite speeds up to 27.4 mph, with torque converter *automatically* matching speed and power to any load. How about a demonstration in your pit? Just call your LeTourneau-Westinghouse Distributor. He'll be glad to oblige.



Over 100 miles of steep, winding mine roads are patrolled by this LW 550, working 2 shifts a day, 7 days a week, in southwestern copper mine. 4 to 6 operators take turns manning it. It's a grueling assignment, but LW graders have the matched speed, power and structural strength it takes to lick long-hour work schedules.

G-2281-MQ-1

LeTOURNEAU-WESTINGHOUSE COMPANY, PEORIA, ILLINOIS

A Subsidiary of Westinghouse Air Brake Company

Where quality is a habit



Haulpak® is delivering at LOWEST NET COST

Acceptance of the LW Haulpak, first all-new truck in a quarter-century, has been fast. Perhaps the best explanation for this wide-spread acceptance comes from *owners** themselves. One puts it this way: "We needed trucks large and rugged enough to handle big loads, yet fast and maneuverable enough to do it *economically*. And we believe that with Haulpak, *we have it!*" Another says: "Haulpaks have cut our truck maintenance costs *almost in half*."

There's a tip for *you* in this owner's comment: "After a trip by three officials of our company to see these units in action, *we chose Haulpak*." Let us arrange a demonstration for you. See first-hand how *you* can get extra tons per hour, at lowest net cost per ton-mile, with LW Haulpaks. 5 end-dump sizes: 22 to 60 tons, up to 550 hp.

▲ Owned 3 . . . bought 3 more!

Enthusiasm for Haulpak trucks runs high at this large U.S. cement plant (above). The firm put 3 LeTourneau-Westinghouse 32-ton Haulpaks to work on 7,100-ft hauls. Adverse grades averaged 1.3% . . . max. was 400 ft of 5% adverse grade. Haulpaks completed cycles in an average of 8.58 minutes. Production per 50-minute hour averaged 179 tons per machine. This steady output, coupled with low-maintenance performance, led to a repeat order for 3 *more* 32-ton Haulpaks . . . making a total of 6 in their fleet to date.

*Names on request

HP-2387-MQJ-2

LeTOURNEAU-WESTINGHOUSE COMPANY, PEORIA, ILLINOIS

A Subsidiary of Westinghouse Air Brake Company

Where quality is a habit

In NEBRASKA

Hauling 32-ton loads of overburden to dump area, LeTourneau-Westinghouse Haulpaks cruise along well-maintained roads at speeds to 38.8 mph. Safe? You bet! There's a total of 5,148 sq in. braking surface on 32-ton Haulpak . . . *four times* the braking area of most comparable-capacity trucks.



In INDIANA

27-ton Haulpak highballs over typical quarry road. Hydrair® suspension cushions travel shocks . . . keeps load riding level, reduces spillage during high-speed haul. Center of gravity is *low*, because about 6 tons of material are carried *below* normal truck floorline in Haulpak's deep V-body.



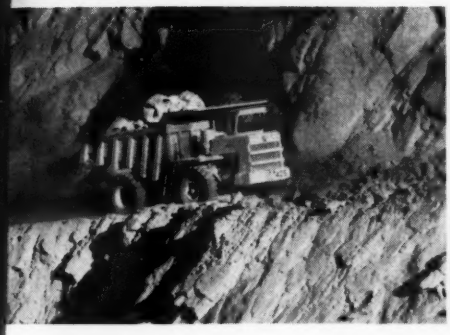
In UTAH

Here's the big 550-hp, 60-ton Haulpak in action. This latest addition to LW line, carries almost *twice* its own weight in payload capacity! Weighs approx 66,000 lbs, carries 120,000-lb payload. Reason: high-tensile-strength steels, nearly 3 times stronger, ⅓ lighter than in ordinary trucks.



In CALIFORNIA

Heaped with rock, 32-ton Haulpak shows plenty of power and pep as it climbs grade. Pit-to-plant hauls are long . . . grades, steep and winding. Talking about acceleration and power, another LW owner reports: "Our Haulpaks come out of the pit in a higher gear, and at a faster rate of speed, than any unit we are familiar with."



In NEW MEXICO

Over-the-edge dumping minimizes clean-up on this waste bank. Notice how edge of bowl swings low, well back of rear wheels, as the body starts to raise. Dump action is fast, too! Twin hydraulic rams lift the body to full dump-angle in approx 16 seconds. LeTourneau-Westinghouse Haulpak shown below is 27-ton size.



In PENNSYLVANIA

Stripping contractor owns 4 of these LW 32-ton Haulpaks. Comparing them with conventional 22-ton trucks, contractor says: "Haulpak's short turn-around, plus high hauling speeds, mean that each of these 32-ton trucks gains one complete round trip in every seven on hauls of average length. Ours vary from 800 to 2500 feet."



PER TON-MILE for owners everywhere

In ILLINOIS

At this strip-mine, special *bottom-dump* Haulpaks carry 90 tons of coal per trip. Performance-proven since 1957, this giant LW hauler has: springless Hydrair suspension on all wheels, Hydrair trailer-hitch, Power-Transfer differential, and many other "firsts" in big trucks.



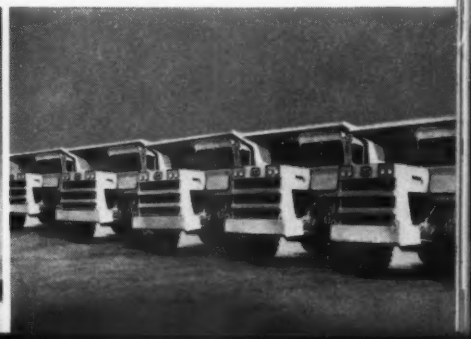
In NEVADA

This 60-ton Haulpak works around the clock, 7 days a week, on a mile-long haul. Average adverse grade: 7%. It's a grueling assignment, but LW Haulpak has the matched power, speed, and structural strength it takes to beat tough work schedules. Haulpak's production: 1668 tons per 7-hour shift!



Destination: LIBERIA

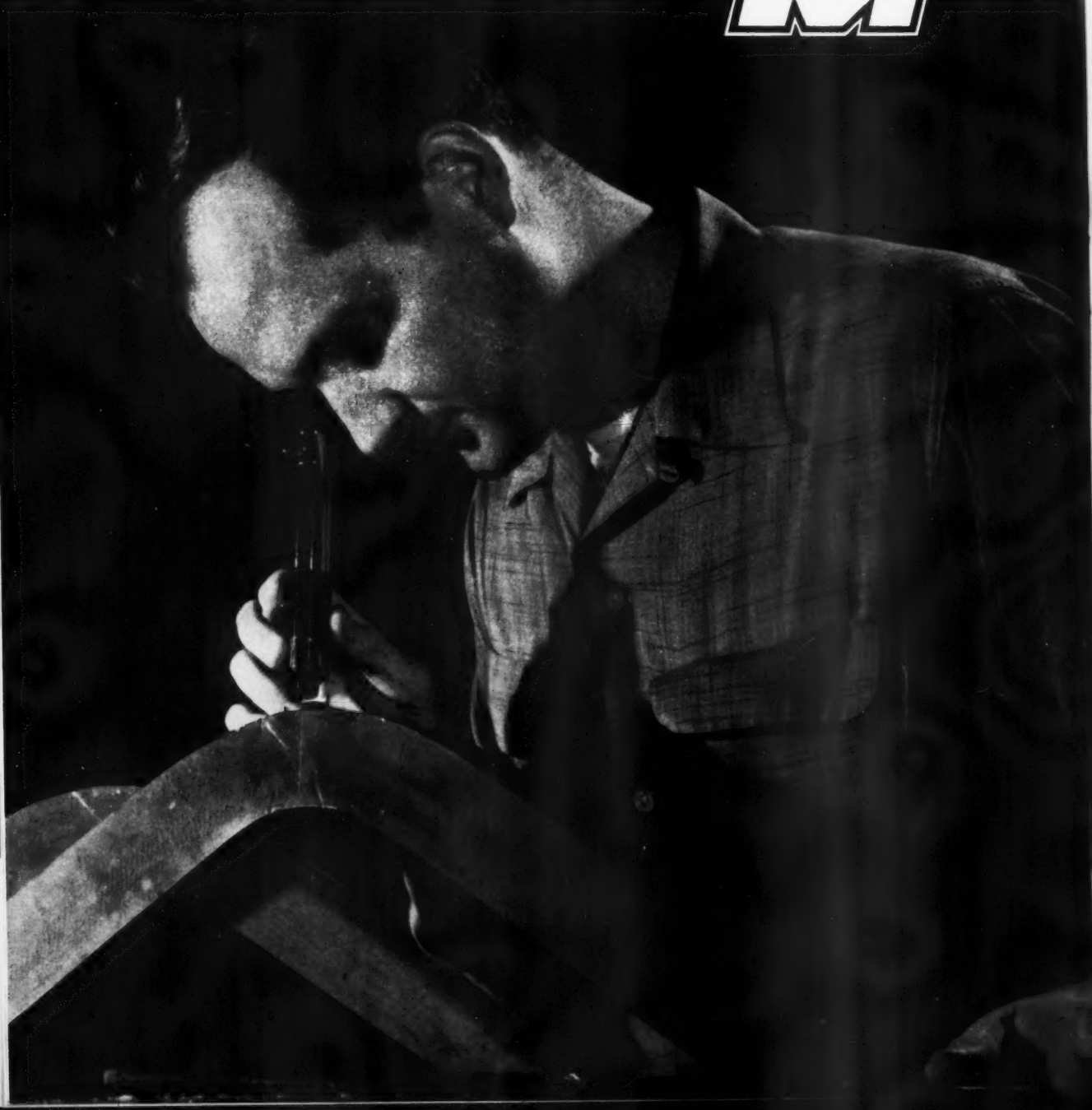
With 5 LW Haulpaks already at work, 7 more are on their way to a Liberian mine. Here's part of the latest 27-ton Haulpak fleet being readied for overseas shipment. In addition, the African mining firm has 2 LW 440 graders, and 9 C Tournapulls® building a railroad service line.

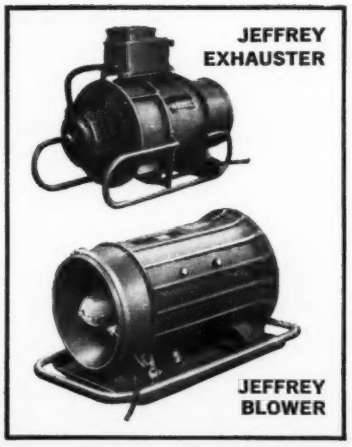


THIS IS MARION QUALITY.

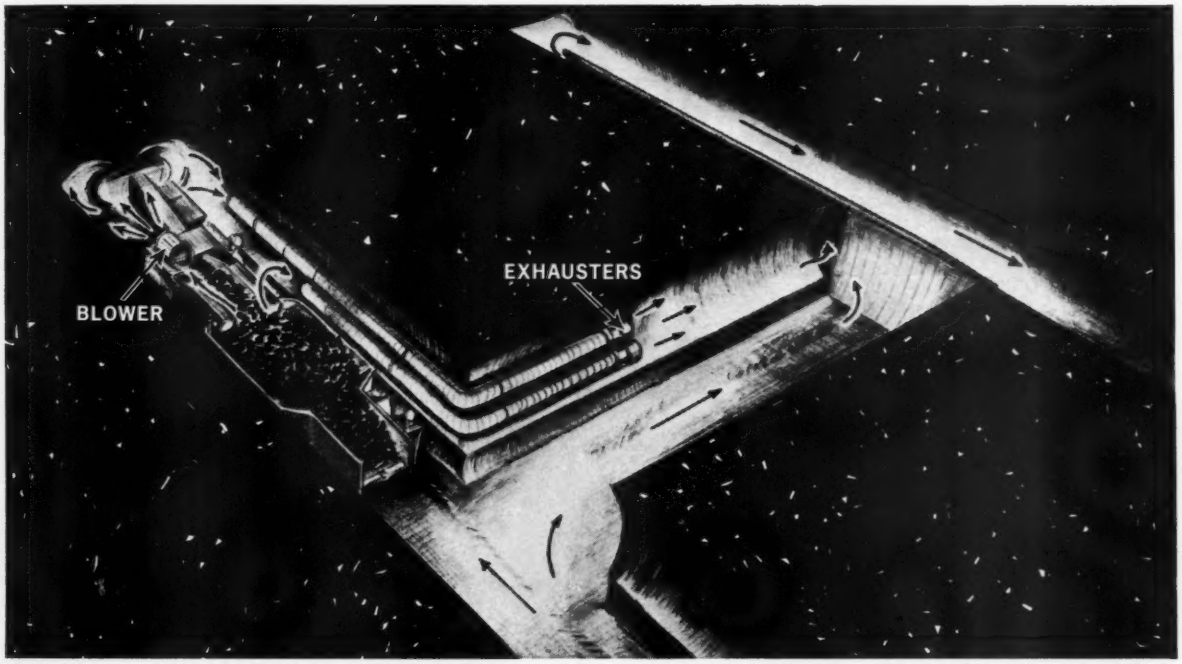
Strange things can happen to steels in the −50° temperatures encountered on the Iron Range. At such readings, ordinary steels can snap like brittle spaghetti. It's one of the big reasons why Marion uses high strength, high alloy steels at vital points throughout their intermediate size excavators. But, these new steels offer machine owners more than just excellent cold strength characteristics. For one thing, they're more resistant to fatigue and heavy shock loading. More important, their inherent strength permits lighter construction. That means your operator is lifting less dead weight... more payload. The man in the picture? Marion takes nothing for granted. He's performing one of dozens of quality check tests that every piece of steel undergoes, from the Marion laboratory to the final assembly station. The long way around? Perhaps. We're willing to let the profit figures for these Marions settle that one. Marion Power Shovel Company, Marion, Ohio. A Division of Universal Marion Corporation.

MARION





Here's how to use Jeffrey Auxiliary Fans to reduce explosion hazards



Jeffrey cooperated with mining engineers to design this ventilation system, now proved out by the U. S. Bureau of Mines.

When you force fresh air across the working face, you dilute any gas being liberated and move out dust—so the exhaust system can more easily clear the atmosphere. Explosion hazards are reduced, visibility is improved—increasing the miners' efficiency.

A Jeffrey Blower mounted on the mining machine blows fresh air forcefully against the working face, diluting and moving out methane to the suction duct. The Jeffrey Exhauster pulls gas and dust-laden air out of the work area through the tubing and discharges it out into the return air course, keeping the atmosphere clear.

Whether your ventilation problems involve moving small or large volumes of air, ask Jeffrey engineers for help. Catalog 901 describes the equipment. The Jeffrey Manufacturing Company, 958 North Fourth Street, Columbus 16, Ohio.

If it's conveyed, processed or mined, it's a job for Jeffrey.

JEFFREY



40-cubic-yard shovel stripping overburden at the Victoria Mine, Peabody Coal Company, Boonville, Indiana.

15,057,400 yards of overburden removed

with five USS Tiger Brand hoist ropes

This 40-cubic-yard shovel operates 85% to 90% of the time around the clock at the Victoria Mine of the Peabody Coal Company, Boonville, Indiana. It is rigged with a USS Tiger Brand 2⅜" shovel hoist rope 624' long and the 100' 10" long boom supports are made from 3⅝" diameter USS Tiger Brand Galvanized Strand.

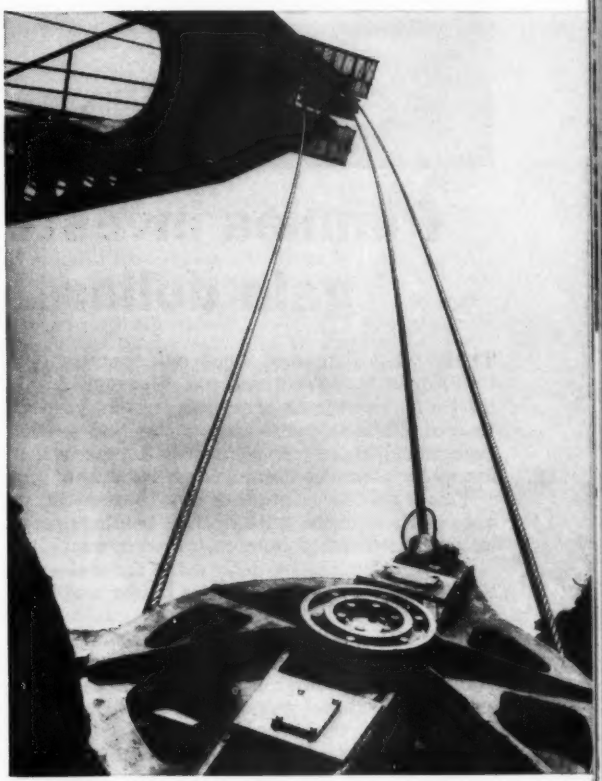
Production records for five hoist ropes show an average of 3,011,480 yards of overburden removed per rope. Such service is the main reason why USS Tiger Brand Wire Rope is used on so many big shovels. Jobs like this call for a wire rope that's engineered with the right combination of strength, flexibility and resistance to abrasion, fatigue and crushing. Tiger Brand fills the bill.

Why USS Tiger Brand is your best buy

Tiger Brand Wire Rope is designed by one of the industry's most capable staffs of wire rope engineers. It is made by a company that maintains the most complete research and manufacturing facilities in the steel industry. When you buy Tiger Brand you get the right rope for the job. It's available from a nearby distributor. And your installation is no further away than a phone call from experienced American Steel & Wire field service representatives.

For more information write American Steel & Wire, Dept. 1145, 614 Superior Avenue, N.W., Cleveland 13, Ohio.

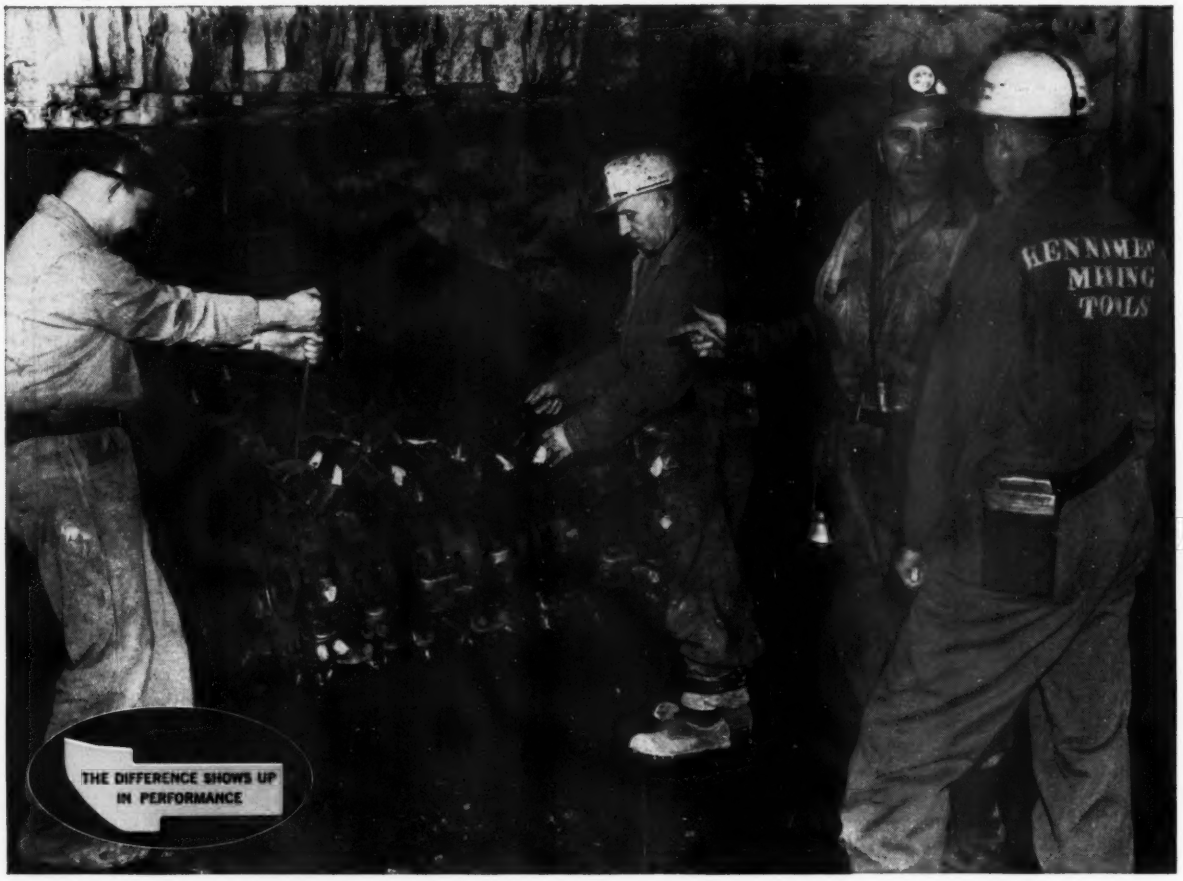
USS and Tiger Brand are registered trademarks



USS Tiger Brand 2⅜" hoist rope that had a service life of more than 3,000,000 cubic yards of overburden.

American Steel & Wire Division of United States Steel

Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors • Tennessee Coal & Iron Division, Fairfield, Ala., Southern Distributors • United States Steel Export Company, Distributors Abroad



Pennies invested in bit cost per ton... gain dollars in tonnage per shift

That's what happened when one operator decided to try Kennametal* cutter bits. Although his bit cost increased four-tenths of a cent per ton, production increased 82 tons per shift on the test section. This exceptional 33 per cent increase in tonnage was attained in a 98-inch seam containing large amounts of impurities.

This is another example of how the superior performance of Kennametal cutter bits is helping operators get maximum efficiency from costly machines.

Kennametal bits are designed to *cut* coal—not rub it. Kennametal carbide inserts are harder and hold a cutting edge longer. That's why they cut coal faster, require fewer bit changes and less bit regrinding. Time saved underground means more tons above ground.

Bit costs alone are misleading as it's the total cost of getting coal above ground that really counts. If you look at your over-all production figures, you may find that a few cents invested in bit cost may pay off in dollars by keeping your machines producing more minutes per shift. The big difference shows up in bit performance . . . not bit cost.

For a check on how the superior performance of Kennametal bits may help improve production and profits at your mine, call your Kennametal Representative or contact us direct. KENNAMETAL INC., Mining Tool Division, Bedford, Pennsylvania. Phone 623-5134.

33594

*Trademark

Comparative bit costs per ton versus tonnage mined involving Kennametal and competitive bits—based on a company's test report of actual coal mining operation.

Over-All Bit Cost Per Ton		Tons Mined Per Shift	
Kennametal.....	3.5¢	Kennametal.....	331 tons
Competitor.....	3.1¢	Competitor.....	249 tons
	0.4¢		82 tons
Kennametal is 0.4¢ higher.		Kennametal bits produced 82 tons more coal per shift.	



See our display at the Coal Show—Booth 1818

INDUSTRY AND **KENNAMETAL**
...Partners in Progress

EDITORIAL

Wanted! Mining Students

The mining industry is fortunate that some of its best men have gone into the field of education in the mineral sciences, a vocation with its own set of rewards and drawbacks. Among these drawbacks is the fact that the faculties of college mining departments are in some cases spread too thin—with time for little more than keeping abreast of technical advances and devoting proper attention to classroom presentations. The matter of recruiting new students for future classes has frequently not received enough attention, and the mining industry owes it to its educators to help raise enrollments in mineral engineering colleges.

Evan Just, head of the Department of Mineral Education at Stanford, in his article, "Future of Mining Education," in the February 1961 issue of MINING CONGRESS JOURNAL, pinpointed the problem in his statement that, "For an industry utterly basic to civilized living and, in the United States, producing $9 billion worth of raw material annually, employing 530,000 people and handling 3½ billion tons of material annually, the present supply of less than 200 graduates in mineral engineering per year is grossly inadequate." He went on to explain that the argument for larger mining enrollment "devolves principally on the need for specially trained managerial personnel."

We fully subscribe to this thinking. While many electrical, chemical, mechanical and civil engineers—to list but a few—have made important contributions to mining technology, the man who has been especially trained from the start in the many sciences involved in mineral production is most fully equipped to understand the overall problems of mining. There will always be notable exceptions, but our mining colleges are, we believe, turning out the men with the best overall background to develop themselves for managerial positions in mining companies.

In their recent report, "Mining Engineering—a Dying Profession? Should It—And How Can It—Be Revived?" Professors Joseph Newton and J. W. Whiting of the Department of Mining and Metallurgy, University of Idaho, took the mining industry to task for its apparent indifference to the serious problems faced by the mining schools. The authors made a survey of mining executives to determine what the industry expects of a mining engineer — the results of which were summarized in the report. Their conclusion was that the task of stimulating interest in mining engineering education rests squarely and solely on the shoulders of the mining industry.

This report, whether or not one agrees with its thesis, served a worth-while function in provoking further analyses of the problem of low enrollment in mineral education.

Dr. J. D. Forrester, chairman of the Council of Education of AIME and dean of the College of Mines at the University of Arizona, in an address at St. Louis last February, disagreed with the Newton-Whiting view, saying that educators "should not depend on the mineral industry to give us the answers and to pull us out of the hole we have dug . . . through our complacency and our failure to recognize the specific problem."

Forrester emphasized, first, the need for new, properly trained and qualified engineers. Too often, he said mining companies have had to attempt to meet the scarcity of engineers by using subprofessional personnel or by sacrificing technological progress, thus contributing to higher operating costs rather than to the development of improved methods—a luxury which the industry cannot continue to afford.

Taking the position that the heads of mining schools are basically engineers first, and educators second, Forrester went on to say, "Each of us is engaged in a mining enterprise. Our respective student bodies are our ore reserves and it is our responsibility to maintain them and to guide their proper production." He called for a vigorous campaign of "development work" in the secondary schools, to stimulate interest and enrollment in mineral engineering careers. "Our responsibilities are clear," he said. "We must get out and 'beat the bushes' and promote with all possible zeal and vigor" the exceptional opportunities and advantages of the mineral engineering profession. "This is a recruiting matter that is basically the responsibility of the educators, but the total program will require also the active assistance and cooperation of industry and of professional institutes and societies."

Another survey made by A. W. Knoerr, editor of *Engineering and Mining Journal* indicated that there is a surprisingly unified opinion on basic questions of mineral engineering education on the part of mining industry leaders. Commenting on his survey, Knoerr said, "Obviously, the subject concerns them deeply. And, it is equally clear that mining educators are eager to expand their contribution to mining progress."

Shedding more light on the "ills" of mineral education, Dr. Truman H. Kuhn, dean of faculty at the Colorado School of Mines, outlined to the Mining and Metallurgical Society of America some of the factors responsible for the lower enrollment of students in mining courses. He went on to explain the broad nature of present-day mining education, and discussed the changes in curricula at "Mines," made in consideration of the changing needs of industry. Kuhn presented overwhelming evidence that mining engineering graduates *are* wanted, if not by the mining companies, then by other technically oriented organizations who recognize the outstanding value of their broad and rugged training.

Throughout all of these discussions, there is a plea to the industry for solid support of mineral education. We believe America's mining companies are ready and anxious to lend this support—in any situation where they are convinced that a program of improvement is well conceived and properly directed. Most of our major mining companies have already contributed to building funds, scholarships and graduate fellowships. But the basic problem of low enrollment remains.

For those who may be uncertain as to how they can help solve this problem, Dean Forrester called for action along all possible avenues, listing several as follows:

a. Make personal contacts with students in junior high schools and high schools—and with their parents.

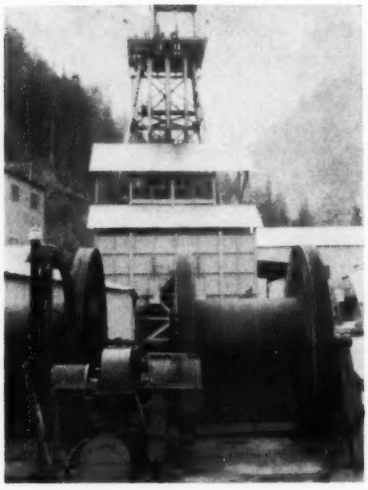
b. Distribute career booklets, films and brochures to students and parents.

c. Exploit all possible channels of good publicity such as those which exist in newspapers and popular magazines. "Play up" and glamorize the opportunities in mining.

d. Develop more undergraduate and graduate scholarships and fellowships whereby worthy students in need of financial assistance can receive support.

Other approaches were covered in the editorial, "Digging Talent Out of High Schools," in the March 1960 issue of MINING CONGRESS JOURNAL.

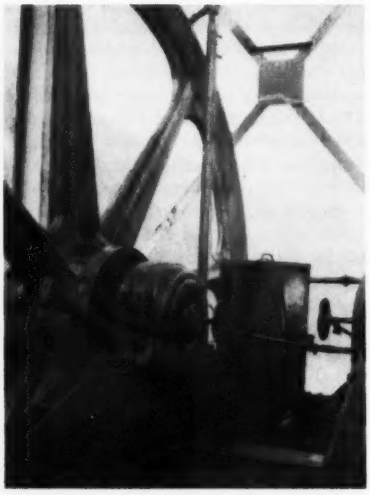
We believe that the faculties of our mining schools are a vital part of the mining industry, and that the problem of increasing the supply of mining engineers is an *industry* problem, involving both educators and mining companies. The solution of this problem calls for close cooperation and unremitting effort by all those interested in the future progress of our most basic industry.



Two rope-changing spools with an air-driven motor gear-head facilitate installing new ropes and reversing ropes end-for-end. Headframe and ore bins are in the background

Special Features of the Galena Mine Hoist Installation

Deep mining at the Galena mine has imposed problems of hoist operation which have varied as conditions change and required operating management to take a close look at some of the technical advances that have been made and are available today



Hoist ropes are lubricated by means of a liquid lubricant that is dripped onto the ropes at the sheave wheels. Shown is the lubricator pump assembly and tank

By NORMAN VISNES
Superintendent
Galena Unit
American Smelting & Refining Co.

THE Galena mine is an older property in the Coeur d'Alene Mining District, having been reopened in 1947 by American Smelting and Refining Co. and Day Mines, Inc., under lease agreement with the owner, Callahan Mining Corp. Management and operation are by American Smelting and Refining Co.

When rehabilitation work was started in 1947 many of the original openings were standing well and, with the exception of 100 ft of collar, the main shaft was in good condition to the bottom, 845 ft below the collar. Some of the shaft was two compartments and some three. This was deemed insufficient, so it was opened out to four compartments in line from collar to sump with the two hoisting compartments in the middle, the manway-pipe compartment on the east end and the ventilation compartment on the west end.

With sea level for a target, sinking was started and, at 1080 ft, loose, heavy ground conditions forced management to change the shaft cross section from four compartments in line to four compartments square, thereby shortening the length of the wall plates which were receiving heavy wall pressures. From 1080 ft below the collar to the present sump, 4035 ft below the collar, the shaft is square and contains two hoisting compartments measuring 50 in. by 58 in.

Small Compartments Limit Hoisting Practice

The small compartment size is the basic limitation to hoisting practice. It limits the size of all shaft conveyances as well as all equipment used in the mine. Lowering mine cars, locomotives, fans, pumps and other equipment requires dismantling and slow hoist operation.

A second limitation is the hoist. It is a 900-hp Nordberg second-motion hoist with a duty rating of 50,000 lb rope pull, and is capable of pulling large loads from our depth of 4000 ft. To realize the full capability of the hoist in the small shaft cross section, an unusually long, slender skip is necessary.

Additionally, the hoist is slow for deep level hoisting, having a top speed of about 1000 fpm, giving an average of 9 to 12 skips per hour of steady hoisting.

A third limitation is imposed by the headframe. This headframe was built for sinking and measures only 85 ft from the shaft collar to the sheave wheel. The low height and long skips force placement of all cages below the skips.

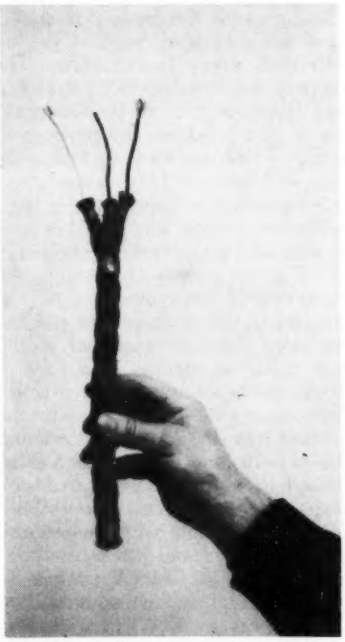
New Bottom-Dump Skips Installed in 1958

When the present hoist was installed in 1951, bottom dumping skips with guillotine type gates were built in the company shops and put into service. These were used until the fall of 1958 when they were replaced with new Card-designed bottom-dumping skips.

The old skips met mine requirements for most of this period, but there were a few operating problems, one of which resulted from excessive weight. It was felt that redesign and simplification could correct these problems. All the operating problems could have been lived with except the excessive weight, which would limit the payload from 4000 ft to such an extent that it would be impossible to hoist mill tonnage and have time to accomplish the necessary repairs in the main shaft.

Aside from the weight, the two main skip problems were: (1) failure of the guillotine door to close after dumping, and (2) the accumulation of flyrock around the shaft collar and ore bin, this resulting from tacky or sticky muck coming out of the skip slowly. The first of these problems was the major one since there were a number of occurrences of bridged muck in the skip hanging up and at the same time holding up the gate, later releasing in the shaft on the return trip. This in turn caused unsafe shaft conditions not cleared until an inspection and clean down was made. There was also more than one case of an empty skip with open door returning to the loading point, where muck from the pocket passed through the skip and door, and down the shaft.

The new skips were designed to eliminate the existing problems including that of weight, and at the same time to increase capacity. They were purchased and put into service late in 1958. Largely because the dumping arrangement is simple, the changeover to these skips was accomplished without significant loss of time.



Section of fiber rope core showing internal conductor wires which relay signals to the hoistman while the cage is in motion or at rest

Capacity of each skip is 123-cu ft. This could lead to the imposition of excessive loads on the hoist ropes when hoisting ore from the bottom levels. As a result, maximum loading marks have been established for ore trips from the three bottom levels. The full capacity of the skips is utilized for ore on all other levels, and for waste from all levels. These restrictions keep the factor of safety on the hoisting ropes well within state and company safety regulation requirements.

Skip Dumping Observed on TV Monitor

The skip will not come down out of the dump if the door is held open, which occurs when dumping is incomplete. This feature, which on balance is desirable, does present at least one problem. Without some special means of being informed when the skip is held in the dump, the hoistman may continue to keep the hoist in motion for a period of time before discovering what has occurred, and unreel a considerable amount of slack rope into the hoist drum pit. The answer to the problem came with the installation of a TV monitor allowing the hoistman to observe both skips when they are in the dump. This installation is described later in the article.

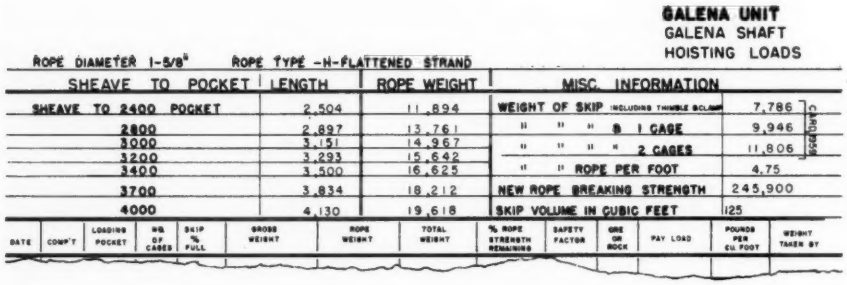
The second problem of flyrock around the skip dump is eliminated entirely by the new skips. The door of the skip hinges down and forms a slide for the muck into the bin. There has been no debris or accumulation of loose fine muck around the collar since the skips have been in use.

These skips are much lighter than the old ones, but they have stood up well in use due mainly to the application of alloy plate wherever advantageous. Each skip weighs 7786 lb complete with rope thimble and clamps. With one cage the total weight of each is 9946 lb and with two cages 11,806 lb. A skip only is 23 ft long; a skip with two cages is 45 ft in length.

The cages are designed so that two fastened together function as a single double-deck cage, with the floor of the top deck folding back and allowing the use of the combined length of the two for lowering long material into the mine. The weight of the cages has been held to a minimum. The bottom deck is readily removed at the collar of the shaft with a fork lift truck prior to hoisting ore. One man operating the lift truck and another removing pins can take the cage off in less than two minutes and replace it in three.

Flattened-Strand Rope Adopted For Deepened Shaft

From 1951 until late in 1958 Galena hoist ropes were 1⅝-in. Improved Plow Steel wire rope with fiber core. When the mine was deepened to the 3400 Level, and then to the 4000 Level, it became necessary to use flattened strand 1⅝-in., 6 by 27 H Improved Plow Steel wire rope to meet the increased load, and also to resist the crushing of multiple wrapping on the drums. The ores from these levels are heavier and the dead load was increased by the added length of suspended hoist rope. Because of these circumstances, it appears now that 4000 ft is approaching the limit for the Galena shaft with



GALENA UNIT
GALENA SHAFT
HOISTING LOADS

ROPE DIAMETER 1-5/8" ROPE TYPE -H-FLATTENED STRAND

SHEAVE TO POCKET	LENGTH	ROPE WEIGHT
SHEAVE TO 2400 POCKET	2,504	11,894
2800	2,897	13,761
3000	3,151	14,967
3200	3,293	15,642
3400	3,500	16,625
3700	3,834	18,212
4000	4,130	19,618

MISC. INFORMATION	
WEIGHT OF SKIP INCLUDING THIMBLE &CLAMP	7,786
" " " " 1 CAGE	9,946
" " " " 2 CAGES	11,806
" " ROPE PER FOOT	4.75
NEW ROPE BREAKING STRENGTH	245,900
SKIP VOLUME IN CUBIC FEET	125

CAPACITY

DATE	COMP'T	LOADING POCKET	NO. OF CARS	SKIP % FULL	GROSS WEIGHT	ROPE WEIGHT	TOTAL WEIGHT	% ROPE STRENGTH REMAINING	SAFETY FACTOR	ORE OR ROCK	PAY LOAD	POUNDS PER CU. FOOT	WEIGHT TAKEN BY

← Report forms used at the Galena Unit provide a permanent record of hoisting system data. The maintenance program is closely tied to the accumulation of information on equipment and operating conditions →

rope strength as the decisive factor.

Flattened strand rope has worked out well at the Galena. There have been no problems with multiple layer wrapping and this type of rope seems to stand the drum crushing loads well.

A maintenance program has been set up for the hoist ropes which is keeping them in good condition. In conjunction with this program a good record of all ropes in service is being accumulated.

Regular weekly inspections are made, including measurements and visual observations. Forms are filled out which record all pertinent information. Copies go to all interested persons. Any change in rope conditions is brought to the attention of the Unit superintendent and the superintendent of maintenance and construction, and immediate attention is given to it. Further, a program of weighing loaded skips has been adopted. This is done regularly to make certain that no overweight loads are being hoisted, and also to keep a permanent record of rope factor of safety as wear takes place.

The mine mechanical department in cooperation with the engineering staff of the rope manufacturer has worked out a system of determining the remaining rope strength from the measurement of the circumference of the rope. Previously used systems of determining the remaining strength do not work well when applied to flattened strand. The following table shows how these measurements are converted to remaining strength:

Outer Wires % Worn	ROPE Circumference	ROPE Diameter	Strength Remaining
0	5-1/8 "	1.6313"	100 %
5	5-3/32	1.6199	98.7
10	5-3/64	1.6085	96.4
15	5-1/64	1.5971	93.5
20	4-63/64	1.5857	90.1
25	4-61/64	1.5743	86.4
30	4-29/32	1.5629	82.4
35	4-7/8	1.5515	78.4
40	4-27/32	1.5401	74.0
45	4-51/64	1.5287	69.7
50	4-49/64	1.5173	65.3

Measurement of circumference has an added advantage of indicating collapse of the rope core as well as showing rope wear.

In line with the inspection procedures each hoisting rope is cut on both ends every four months. The company has installed two permanent steel spools with a single air motor driven gear head for the purpose of installing new ropes and reversing the ropes end for end. This makes it possible to wrap the ropes on the hoist drums very tightly, and it makes rope installation a much easier and quicker job. For the purpose of cutting the drum end of the ropes, the skip is hung up in the shaft bottom and the suspended rope is supported at the shaft collar in clamps. The rope is cut on the hoist drum. This practice has worked well, as evidenced by the fact that it is possible to cut the drum ends of both ropes in less than a shift.

The hoist ropes are lubricated with a drip mechanism at the sheave wheel. A liquid lubricant with penetrating qualities is used and has worked out well. Previously, a tacky lubricant which built up and accumulated on the rope was used. When water got into the core it was held there with the previous lube. This problem does not occur with the liquid lube, which also gets into the core better. Cut samples of rope returned to the manufacturer have shown more lubricant in the core than when the rope was closed. The company has been pleased with this method of lubrication and the resultant condition of the ropes.

Conductor Cores in Hoist Ropes Mean Safer Hoisting

For the last four years, the company has been experimenting with copper conductors in the cores of hoist ropes. These conductors have been of great value when usable, but it has not yet been possible to keep all the conductors in a single rope functioning throughout the life of the rope.

The conductors are used as a means of getting signals to the hoistman from the cage at rest or in motion. Normally, the signals are transmitted through the use of a conventional pull-bob. Also, a part of the system is a signal switch which is coupled into the lever arms actuating the safety dogs on the skip. The arrangement results in any action of the dogs being transmitted as a signal back to the hoistman. As a safety precaution, this one application of the conductor cores justifies the added cost of this type of hoist rope.

Ability to signal the hoistman from the cage whether at rest or in motion is particularly beneficial when carrying on shaft repairs or lowering large equipment into the mine.

When using the old skips with guillotine doors there was a switch on the skip so wired through one of the rope core conductors that the hoistman was warned if the door remained open when the skip came out of the dump. This application is not required in the present installation.

Electrical continuity from the hoist end of the rope to the hoistman is maintained through a collector ring around the drum shaft with a fixed brush holder picking up the flow of current to the signal bells. On the cage end, a weatherproof cap is placed over the end of the rope and connections are made from there.

As previously stated, the company has been experimenting with these ropes. So far, electrical continuity has not been maintained in the conductors for more than a year. Safety-wise, the application is sufficiently attractive to

MINE HOIST REPORT

Date _____

Mine _____ Shaft _____ N. E. _____ S. W. _____

HOISTS			
1.	Controllers - Hoisting Rate FIM		
2.	Precautionary Speed FIM		
3.	Precautionary Point Top		
4.	Precautionary Point Bottom		
5.	Stop Point, Top		
6.	Stop Point, Bottom		
7.	Precautionary Trip, Ft. to stop		
8.	Overwind Trip, Ft. to stop		
9.	Overspeed Ft. to stop		
10.	Brake		
11.	Clutch		
12.	Clutch and Brake Interlocks		
13.	Drive Shaft, bearings, pinion		
14.	Drums, Main Shaft, Bearing Main Gear		
15.	Motors, Electrical Equipment		
16.	Other Hoist Parts		
SKIP AND CAGES			
17.	Safety Dogs and Springs Condition		
18.	Safety Dogs and Springs, Drop Test		
19.	Safety Dogs and Springs, Free Fall Test		
20.	Draw Bars, Body, Frame, Shoes, Hood		
21.	Dumping Plates and Guides		
22.	Main Gates		

REMARKS:

I have personally inspected parts of hoisting equipment as per section, and to the best of my knowledge this report shows the tr

Original to Mine Superintendent.
Pink copy to Mech. Cons. Supt.
Green copy to Asst. Mgr. to be circulated.
Blue copy for Inspectors.
White copy to stay in hoist room.

ROPE INSPECTION REPORT

Date _____

Mine _____ Shaft _____ N. E. _____ S. W. _____

ROPE			
23.	Date installed		
24.	Condition of Drum end		
25.	Date Drum end last cut		
26.	Condition of Rope Clamps or socket		
27.	Date Cage end last cut		
28.	Internal condition of cut off Rope, skip end		
29.	Date Rope last lubricated		
30.	Least number of laps on drum		
31.	Measured rope diameter new		
32.	Measured rope diameter present minimum		
33.	Total number of broken wires		
34.	Maximum number of broken wires one lay		
35.	Percentage rope area intact, Roebling method		
36.	Present safety factor of rope based on No. 35		
SHEAVES			
37.	Diameter of grooves		
38.	Shaft bearing, spokes, etc.		
39.	Does Hoistman say everything is O. K.		

REMARKS:

I have personally inspected parts of hoisting equipment as noted above, in accordance with instructions covering hoisting inspection, and to the best of my knowledge this report shows the true condition of the hoisting equipment at the time indicated.

Original to Mine Superintendent.
Pink copy to Mech. Cons. Supt.
Green copy to Asst. Mgr. to be circulated.
Blue copy for Inspectors.
White copy to stay in hoist room.

Signed _____ (Inspector)

justify continued cooperation with the manufacturer in developing the design of a conductor which will stand up under the hoisting stresses in this application.

It is felt that the principal cause of the failure of conductors to date has been the crushing loads of multiple wrapping on the drums. A suitable insulating cover which will stand up under this duty seems to be the main problem. To eliminate the possibility of crushing the conductors at the cage end of the rope, a large thimble with flat clamps is used. Tests have shown that this method of attachment is not injuring the conductors; standard type clamps did cause some damage to conductors.

Use of Closed Circuit TV Shortens Hoisting Cycle

After the new skips had been in use for a few months, on three separate occasions, a skip hung in the dump, and the hoistman, unaware of the hangup, unreeled loose cable into the drum pit. In the first case, it was a major job taking up the slack without damaging the rope. The company therefore began looking for an answer to this problem.

Closed circuit TV was suggested as a possible solution. In February of 1959 the present installation of this equipment was made. The camera and receiver were installed on a trial basis. They fit into the need so fully that they have been in use continuously ever since. This installation has not only ended the problem of skips hanging in the dump, but with the hoistman viewing the dumping action, it has shortened the hoisting time cycle appreciably and has taken all the uncertainty out of the dumping procedure.

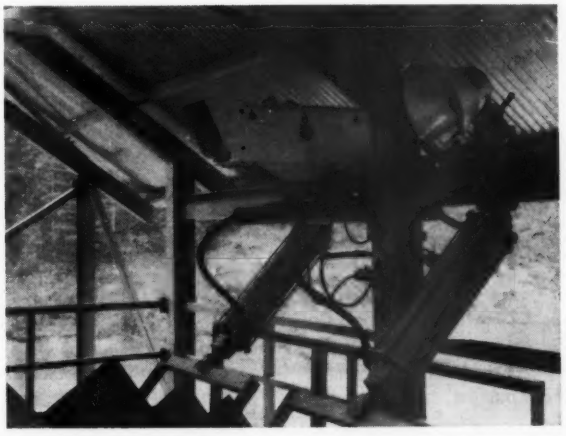
This improvement is particularly noticeable when hoisting heavy ore because rope stretch can be two or three ft longer than normal at the loading pocket. When the hoistman has excessive rope stretch to deal with, he must feel his way into the dumping position with the loaded skip.

The TV installation consists of: (1) the camera in a weatherproof enclosure, (2) the co-axial cable from camera to receiver, and (3) the receiver. The camera is a General Electric Model TE6B1 equipped with a 13-mm wide-angle lens and the receiver is a General Electric 17 in. home-type model. The camera enclosure is a TVCH-2A weatherproof enclosure including blower, filter, windshield wiper, heater and controls.

The installation has given a minimum of trouble. One Vidicon tube has been replaced in the camera, some smaller tubes have been replaced and adjustments have been made during 18 months of service. Total repairs have cost less than $325. The camera has been in continuous use since it was purchased.

Better Hoisting Practice is Key to Greater Capacity

Much of the Galena shaft is in heavy ground, making the possibility of enlarging the cross section to a more efficient compartment size remote at the present time. With this limitation, any improvements in capacity made will have to come through better hoisting practices. Such improvements will become urgent as more and more production come from bottom levels. Keeping future conditions in mind, new techniques are reviewed . which would have any possibility of saving hoisting time, increasing hoist payloads, saving money or improving the safety of the operation. There are many problems, but it is believed that most of them can be solved or reduced. Based on past experience we are sure that improvements will continue to be made.



Closed circuit television permits the hoistman to observe the dumping action of the skips. The installation has speeded up the hoisting cycle and taken all uncertainty out of the dumping procedure. Seen here is the television camera and lighting arrangement at the skip dump

The Slack Coal Problem

Slack must be upgraded if it is to warrant the price necessary to return its fair share of earnings to the mining industry

By ROGER D. CURFMAN

Fuel Agent
The Cleveland Electric
Illuminating Co.

THE coal and electric power industries are rapidly approaching a complementary marketing condition where the major portion of the output of one is the major source of supply to the other.

Figure 1 shows that the electric utility industry's share of the steam coal market, including all export coal, has increased from 14 percent in 1945 to about 52 percent in 1960. Based on today's power production methods, the electric utilities by 1970 will be consuming approximately 70 percent of the steam coal produced in the United States. The curve illustrates the first part of the complementary condition, namely the great impact and control power generation will have on coal production.

Figure 2 portrays the second part of this complementary condition—the power industry's dependence on coal. This curve shows that about 65 percent of the kilowatt-hours supplied by the power industry during 1959 were from coal. Indications are that this percentage will probably increase as time goes on. This statistical evidence of interdependence shows why the electric power industry is vitally interested in the coal industry. Utilities are very cognizant, for example, of coal producers' efforts and achievements in keeping mining costs relatively low, in their research and development programs and in the utilization of radically new methods of mining. The continuous mining machine, extensible conveyor belt and high speed haulage in deep mines, large stripping shovels, high speed drills and ammonium blasting agent in strip mining are some of their more recent cost-cutting contributions.

Coal Is Major Expense Item in Production of Electric Power

The electric power industry is, of course, constantly concerned with the production and preparation costs of coal and what effect they have on market price. Coal, after all, is the electric power industry's largest single item of expense after taxes and labor. The delivered coal cost in today's modern coal-burning power station represents about 70–75 percent of the direct production cost of power. This figure will vary somewhat according to the method and cost of coal transportation used. When measured against total operating expense, exclusive of taxes, the delivered cost of coal for the average power company taking shipments by rail represents about 40 percent of such expense. Figured on an f.o.b. mine cost basis, the coal portion of this expense would be approximately 25 percent.

Electric power is a major expense item in most basic industries today, and coal is a major expense item in the production of electric power. Therefore, the coal industry and associated transportation industries have much to say about industrial production costs nearly everywhere today.

It is this responsibility to all industry, as well as coal's competitive position with other fossil fuels, and with radically new techniques in power production, that require the coal industry to continue to seek out cost and operational problems. Certainly, this is true if coal is to remain the major energy source in the United States.

Because fuel accounts for a major portion of the cost in producing and distributing electricity, one of the major objectives of the electric utility industry must be to use a fuel providing the lowest possible Btu cost at the burners, together with a minimum of associated operating and maintenance cost problems.

Slack Poses Marketing Problem

One of the most pressing marketing problems facing the coal industry today relates to its slack or small-sized product. As the result of certain cost-cutting techniques and changes in markets, slack sizes can no longer be considered a mere by-product. They must be reckoned as a major revenue-earning factor in the over-all mine-run product.

In the past, mining companies have been willing to market their slack at a relatively low price, often below the cost of mining. The economics of this, however, were sound because the slack product amounted to only about 25 percent of the mine-run and could be moved in large volume to electric utilities equipped to handle it. The other 75 percent of the mine-run fitted higher realization markets such as railroads and retail and industrial users that required a more sophisticated product.

Electric utilities in the past have been willing to utilize this lower quality slack increment. They did so because of the versatility of the pulverized fuel furnace and because the low cost of the product more than offset the disadvantages of handling and burning.

Advent of Continuous Mining Increases Percentage of Fines

Modern deep mining techniques and changing markets are completely altering this economic picture.

With the advent of the continuous mining machine—bringing higher mining efficiencies—the percentage of 3/8-in. by 0 slack in the mine-run product has increased from about 25 percent in conventional mining to as high as 50 percent using continuous mining equipment. Figure 3 shows the comparative results for hand-loading, conventional and continuous mining in a coal seam with a firm structure. Continuous miners designed to produce a minimum of fine coal were used. In this actual example the 3/8-in. by 0 size coal increased from 28 percent of the mine-run on a conventional basis to 34 percent on a continuous basis. At the same time, the two-in. plus size decreased from 40 percent to 19 percent.

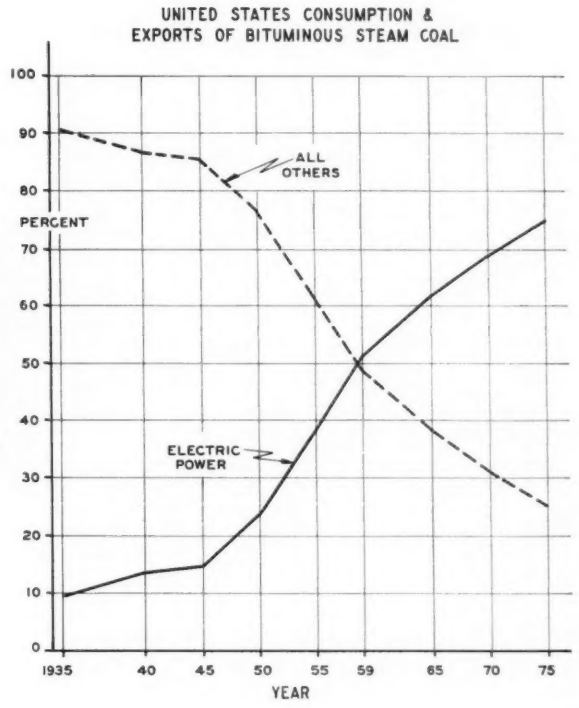


Fig. 1. Curve illustrates the great impact and control that power generation will have on coal production. Based on today's power production methods, the electric utilities by 1970 will be consuming nearly 70 percent of the steam coal produced in the United States

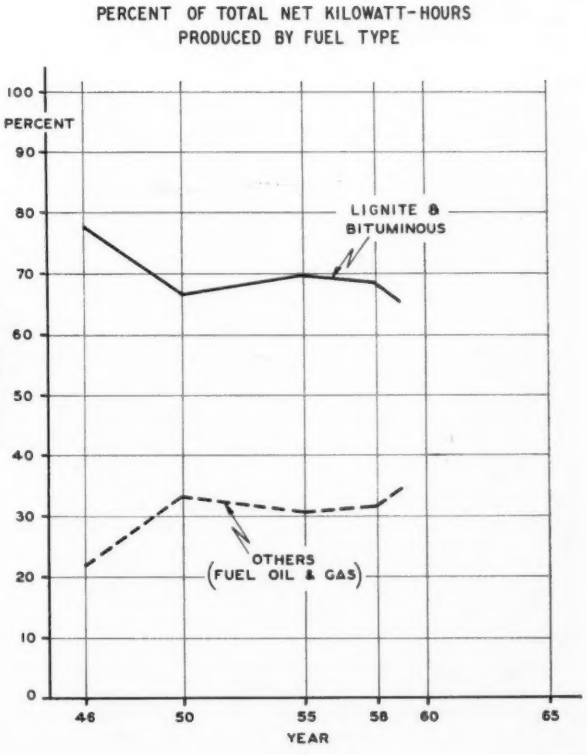
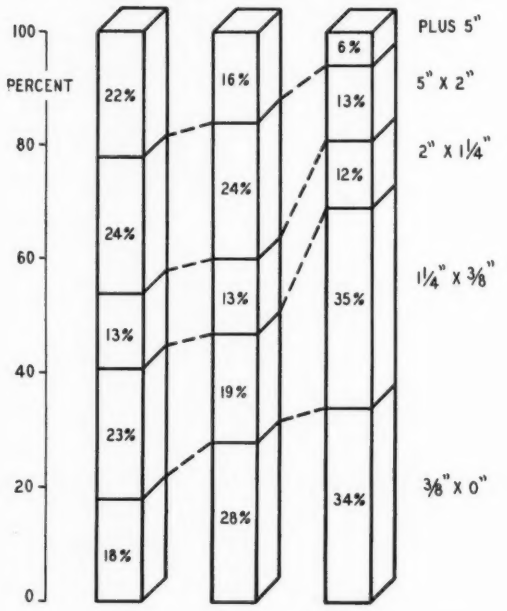


Fig. 2. About 65 percent of the kilowatt-hours supplied by the power industry during 1959 was from coal, emphasizing the power industry's dependence on this fuel

SIZE BREAKDOWN BY MINING METHOD



WEIGHTED AVERAGE REALIZATION

SIZE	REALIZATION	PERCENT CONVENTIONAL	PERCENT CONTINUOUS
5" PLUS	$7.00	16	6
5" X 2"	5.50	24	13
2 X 1¼"	5.50	13	12
1¼" X ⅜"	4.50	19	35
⅜" X 0"	3.75	28	34
TOTAL REALIZATION		$5.06	$4.64

CONVENTIONAL	$5.06
CONTINUOUS	4.64
INCREASE	.42

Figs. 3 and 4. (Left) Effect of mining method on the size consist of coal mined from a seam having a firm structure. Note that the ⅜-in. by 0 coal increased from 28 percent of the mine-run on a conventional basis to 34 percent on a continuous basis. (Right) The weighted average difference in realization for this mine, for the two mining methods, shows a loss of 42 cents per ton on a continuous mining basis as against conventional mining

Figure 4 shows the weighted average difference in realization for this mine, based on the preceding size breakdown for conventional mining versus that for continuous mining. The net realization to the mine in this example is a loss of 42 cents per ton on a continuous mining basis as against conventional mining.

In recent years a reduction in the higher realization markets has compounded the problem in slack coal. Since the beginning of the postwar period in 1948, the coal industry has lost heavily in its higher realization markets. Figure 5 shows that the railroad market dropped from about 95,000,000 tons per year to about 2,000,000 tons, a reduction of 98 percent. Retail trade has been reduced from 87,000,000 tons to 30,000,000 tons or 66 percent. Other industrials are down from 121,000,000 to 84,000,000 tons or 31 percent. This is a total loss of about 187,000,000 tons, a reduction of 62 percent in the high realization product.

To offset this loss coal has increased its sales to electric utilities from 96,000,000 tons to 174,000,000 tons, an increase of 78,000,00 tons or 81 percent. For the most part, however, the per ton realization on the tonnage gained has been less than the per ton realization on the tonnage lost. It is because of this changing economic situation, affecting both the producer and the consumer, that the slack problem is of vital interest to the power industry and should receive the attention of the mining industry at this time.

The electric utility industry is not looking for ways to increase the cost of coal—its largest single item of purchase. On the other hand, it would not be prudent to expect the coal industry to market its high-volume slack coal at a price at or below the cost of mining when there is little opportunity to make up the difference in realization through higher realization markets.

As previously noted, electric utilities have in the past burned lower quality slack due principally to its competitively low price. However, if slack is to carry its share of the mining company's realization through price increases which seem almost inevitable, it will henceforth have to be marketed on merits other than price.

Disadvantages of Using Slack Must Be Overcome

There are several disadvantages of using slack coal as compared with mine-run and other larger sizes. These must be overcome if slack is to warrant the price necessary to return its fair share of earnings to the mining company.

The great majority of the eastern coal seams in this country contain extraneous matter in the form of impurities. These are either more friable than the coal and/or oxidize at a rapid rate and disintegrate, resulting in the impurities finding their way into the smaller-size increments of the mine-run product.

Thus, there is less combustibility in the smaller sizes and the thermal quality accordingly is reduced about 130–140 Btu for each 1.0 percent of non-combustible added. In addition to lowering the heat value, use of such coal is accompanied by several operating and handling problems. One of them is increased slagging on the boiler tubes which acts as an insulation and results in lower heat transfer to the boiler steam. Another is that ash build-up may blanket the hot gas passages in the boiler super heaters and require more frequent operation of the soot blowers. All this reduces boiler efficiency. Coincidentally overloading the ash precipitators results in air pollution problems.

Inorganic sulphur in the form of pyrite and marcasite in unwashed slack also adds to boiler operating costs and reduces efficiency. This is caused by the need for increased stack exit gas temperatures to control air preheater corrosion. The hard pyrites also contribute to excessive pulverizing mill wear.

One of the most pressing problems facing industry today is that of air pollution. Fly ash may be effectively controlled by electrostatic precipitators, but as yet there is no economical method of removing sulphur from

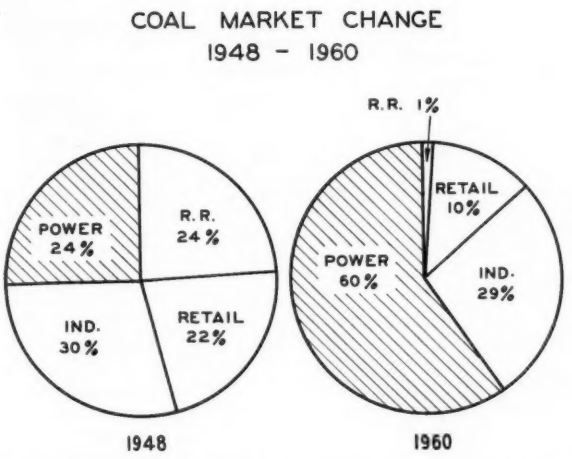


Fig. 5. Coal has increased its sales to electric utilities but lost heavily in its higher realization markets

stack gases. The only effective means of controlling sulphur is to burn lower sulphur fuel. Many mining companies have taken steps to upgrade their slack product by the use of air tables, Deister tables or by passing the product through a jig with the nut and egg sizes. These have proven to be effective ways of removing extraneous non-combustible material from slack-size coal. Yet, if slack is left in a wet condition this small-size coal, with its many exposed surface areas, will retain the moisture and result in a product creating increased operating costs. The major problem here, other than the resulting Btu loss, is the reduction in milling capacity for the boiler. An excess of moisture, especially in fine-sized coal, will reduce capacity in the pulverizing mills. This makes it necessary to shift load to other less efficient power stations or to carry excess mill capacity which adds to the capital investment of the plant.

In addition to these operating problems slack-size coal presents certain handling difficulties, and, as size becomes smaller, the handling difficulties increase in an inverse ratio. During the winter months thawing costs are considerably greater for small-sized coal than for double-screened or mine-run sizes. This again is the product of many exposed surfaces holding moisture, then freezing. When larger pieces of coal are present they tend to break loose more easily and carry the finer sizes out of the car or truck.

Dust, belt spillage and hangup on conveyor belts add to housekeeping problems and increase motor burnouts and belt roller maintenance. In the coal bunkers, bunker capacity is reduced as a result of the lower density of finer coal, and the hangup of coal in the bunkers is more pronounced.

The use of slack coal is not without its benefits, however. Primary crushing is eliminated and the cost of operation and maintenance and power usage may be reduced in the pulverizers.

Sulphur Is Most Costly Impurity

The obvious question at this point is, "If extraneous ash materials, moisture and sulphur are deterrents to efficient coal utilization, how much of a deterrent are they when measured in dollars?" For years the industry has accepted as fact the idea that these extraneous materials add to the cost of burning coal, but very little effort has been put forth to really evaluate their true cost. In an effort to develop these costs, personnel of The Cleveland Electric Illuminating Co. have carried out a study, based on work previously developed by E. H. Tenney, chief engineer of Power Plants, Union Electric Co., and by Schahfer, Strout and Land in ASME paper No. 57-A-115. Actual plant functional costs for a large modern generating station were applied to basic concepts developed by the authors. The following cost adjustment factors for each one percent change in ash, moisture and/or sulphur were developed:

Moisture adjustment factor	**= 0.26%**
Ash adjustment factor	**= 0.44%**
Sulphur adjustment factor	**= 1.52%**

These factors are for one particular plant and will change depending on the age and design of the plant. In most cases they will be higher for older or smaller stations. The true meaning of these adjustment factors is this: for each one percent increase in the moisture content of the coal, the cost of handling and burning this excess moisture amounts to a 0.26 percent increase in the cost of the coal on a per ton basis. In the same manner ash costs increase 0.44 percent and sulphur costs 1.52 percent for each 1.0 percent increase in ash and/or sulphur.

These factors also show the relative detrimental effects of handling the three components. Sulphur is the most costly impurity on a one percent unit basis, costing almost six times more to handle and burn than moisture. Ash is the second most costly item, being about one-third the unit cost of

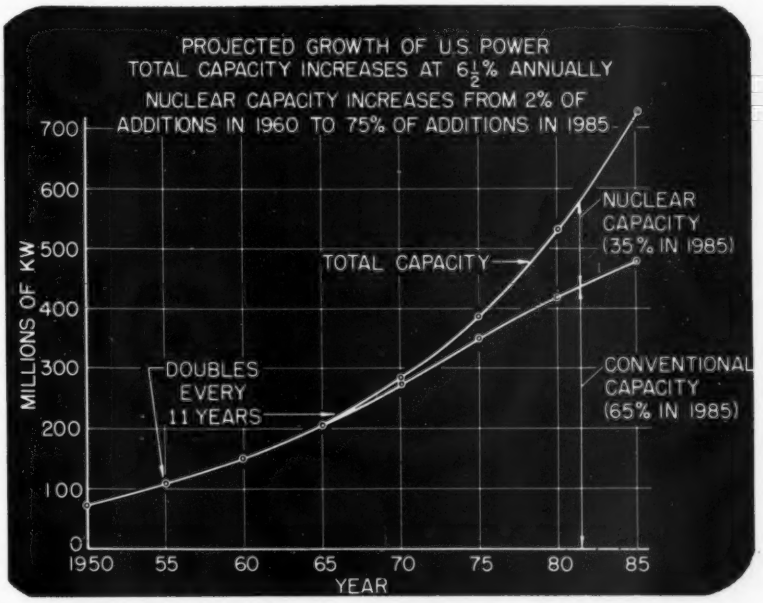


Fig. 6. Projected power growth indicates that expanding nuclear capacity will not halt growth of conventional systems

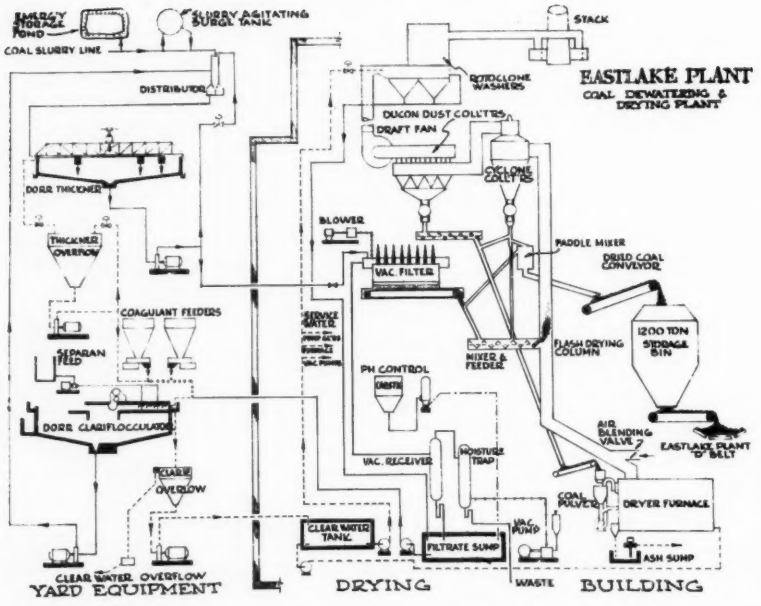


Fig. 7. Flow chart of coal dewatering and drying plant of CEI's Eastlake plant—northern terminus of famous coal pipeline from Cadiz, Ohio

sulphur but almost twice the cost of moisture. Moisture is the least costly of the three. However, if moisture reaches a point where pulverizing mill capacity is impaired, with the necessity of reducing load on the power station, the cost may become very great. This is because less efficient plants are then required to pick up the load.

As an example, take a new power station that produces one kwh of electricity per 0.7 lb of coal burned. If it becomes necessary to reduce load on that station because of high moisture coal and have the load picked up by an older station with a coal rate of 1.5 lb per kwh generated, the fuel cost for this power is doubled. In other words, $6.50 coal becomes $13.00 coal.

The cost increases resulting from the application of the adjustment factors cited represent only those costs attributable to handling and burning. Concurrent with the increase in ash, moisture and sulphur is a reduction in Btu value of the coal, which adds to the devaluation of the product. When these adjustment factors and their resulting lower Btu value are applied to a coal, we find that for each one percent increase in ash, moisture and/or sulphur the cost of burning this coal increases about:

	Handling Cost	*Btu Cost*	*Total Cost*
a) Moisture	**$0.02**	**$0.07**	**$0.09 per ton**
b) Ash	**0.04**	**0.08**	**0.12 per ton**
c) Sulphur	**0.10**	**0.03**	**0.13 per ton**

Formula Used to Compute True Cost of Coal

In the case of excess moisture and ash a large percentage of the resulting excess cost is due to the loss in heat value. Sulphur creates the opposite effect, and the cost of handling and burning this impurity becomes quite expensive. The actual application of the adjustment factors is carried out by applying them to the formula given on this page.

$$\frac{Btu_1}{Btu_2} + (M_1 - M_2)M_F + (A_1 - A_2)A_F + (S_1 - S_2)S_F$$

Btu_1 = Actual "as received" Btu
Btu_2 = Expected Btu
M_1 = Expected Moisture
M_2 = Actual Moisture
M_F = Moisture Factor
A_1 = Expected Ash
A_2 = Actual Ash
A_F = Ash Factor
S_1 = Expected Sulphur
S_2 = Actual Sulphur
S_F = Sulphur Factor

$$\frac{12180}{12500} + (5.0 - 6.0)0.0026 + (10.0 - 11.0)0.0044 + (3.0 - 4.0)0.0152$$

$$0.9744 - 0.0026 - 0.0044 - 0.0152 = 0.9522$$

$6.50 (Cost of Coal) ÷ 0.9522
= $6.83 True Cost of Coal

Thus, there is an added cost of $6.83–$6.50 = $0.33 due to one percent increase in ash, moisture and sulphur. It must be remembered that the adjustment factors will differ depending on the power plant in question. The factors shown above are for a large modern station. They will be lower than the factors for an older, less efficient power plant.

Fine Coal Offers Three Definite Cost Advantages

The Illuminating Co., as the result of its experience with coal pipeline product, has become quite conversant with the handling and burning of small-size coal. This pipeline product has a top size of 14 mesh, about 1/16 in. It is much smaller than the usual commercial slack, which ranges from ¼ in. to ⅜-in. top size.

The utilization of this very small product over a period of three years crystallized the company's thinking concerning the advantages and disadvantages of handling and burning a washed and dried small-size coal. It must be kept in mind that the pipeline product is 100 percent 14 mesh or smaller while ⅜-in. by 0 slack from a continuous mining operation contains only about 30 percent 14 mesh by 0 increment.

There are three very definite cost advantages from the use of washed and dried fine coal.

1. **Pulverizing mill life is increased about 30 percent, which means that mill maintenance costs are down about one-third.**
2. **Mill power requirements are reduced about ten percent.**
3. **Coarse coal crushers may be bypassed, eliminating the cost of operating and maintaining this equipment.**

These combined savings—using approximately 100 percent washed and dried slack rather than a mixture of about 50 percent mine-run and 50 percent raw slack—amount to about four cents per ton of coal. In a power station using 1,600,000 tons per year the saving would be $64,000. The company feels that these savings, developed on pipeline product, would be about the same for washed and dried slack up to ⅜-in. top size.

The disadvantages accruing to the use of small-size coal are all chargeable to handling and are difficult to evaluate on a dollar basis. The company has found that the higher the percentage of very fine coal, 14 mesh by 0, the greater the risk of a hangup in the bunkers. Bunker hangup results in irregular coal feed to the furnaces

and erratic air-fuel ratios. This, in turn, affects combustion efficiency and makes for smoke air pollution problems.

Constant hangup requires the installation of rapping devices on the bunkers. These result in higher bunker maintenance costs. When thermally dried fine coal is mixed with coarser sizes in the same coal bunker, the tendency is for the fine dried coal to absorb moisture from the larger sizes. This aggravates the coal hangup problem in the bunkers. Bunker capacity is also reduced as coal size becomes smaller, the result of the lower density of the smaller sizes.

Excessive dust from slack results in public relations problems when stockpiling and increases plant housekeeping problems and conveyor belt motor burnouts. During the winter months thawing costs are greater for small-sized coal than for larger sizes.

Slack Coal Preparation Is Costly for Results Obtained

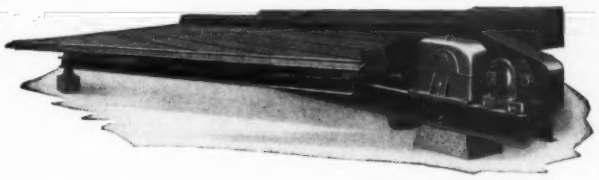
The marketing goals for slack coal are quite clear if slack is to supply its fair value of total realization through a higher price. The utilities will expect a product containing a minimum of extraneous non-combustible material and pyritic sulphur, a surface moisture content low enough to permit satisfactory pulverizing mill operation, and a size containing a sufficiently high percentage of coarse increment to minimize dust and handling problems. All of this must be furnished at a cost which gives coal an economic advantage over other fossil fuels and new power production techniques.

This is an ambitious program and a program which, based on today's preparation methods, carries a high price tag. Many mining companies are moving in the direction of washed and dried slacks, and The Illuminating Co. is not without experience in dewatering and drying pipeline coal. All of this experience points up the fact that slack coal preparation, especially the dewatering and drying cycle, is a very costly operation for the results obtained.

Based on today's economics, the cost of operating and depreciating a fine coal preparation plant amounts to about 75 cents per ton. If a company were to upgrade a slack product by lowering the moisture two percent, the ash three percent and the sulphur one percent, correspondingly increasing the Btu, and apply these changes to the adjustment factor formula mentioned, the value of this coal would increase about 60 cents per ton.

The coal industry finds itself in a situation similar to the paradox of the dog chasing its tail. In order to reduce production costs industry must produce more slack; when more slack is produced and represents a higher percentage of the mine-run product, it must demand a higher price; and if slack is to demand a higher price it must be upgraded, which, in turn, requires costs excessive by today's standards.

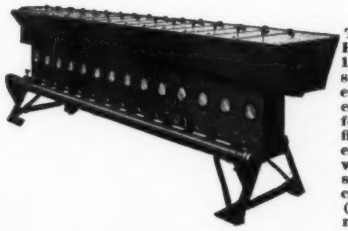
Much effort and money has been expended to reduce costs underground, and with satisfactory results. The coal industry and associated equipment manufacturers must now turn their efforts toward the slack problem and devise a slack coal preparation cycle requiring no more than reasonable operating and maintenance costs. It is a fundamental necessity if slack is to continue to be an economically desirable product to handle and burn in today's modern steam generating station.



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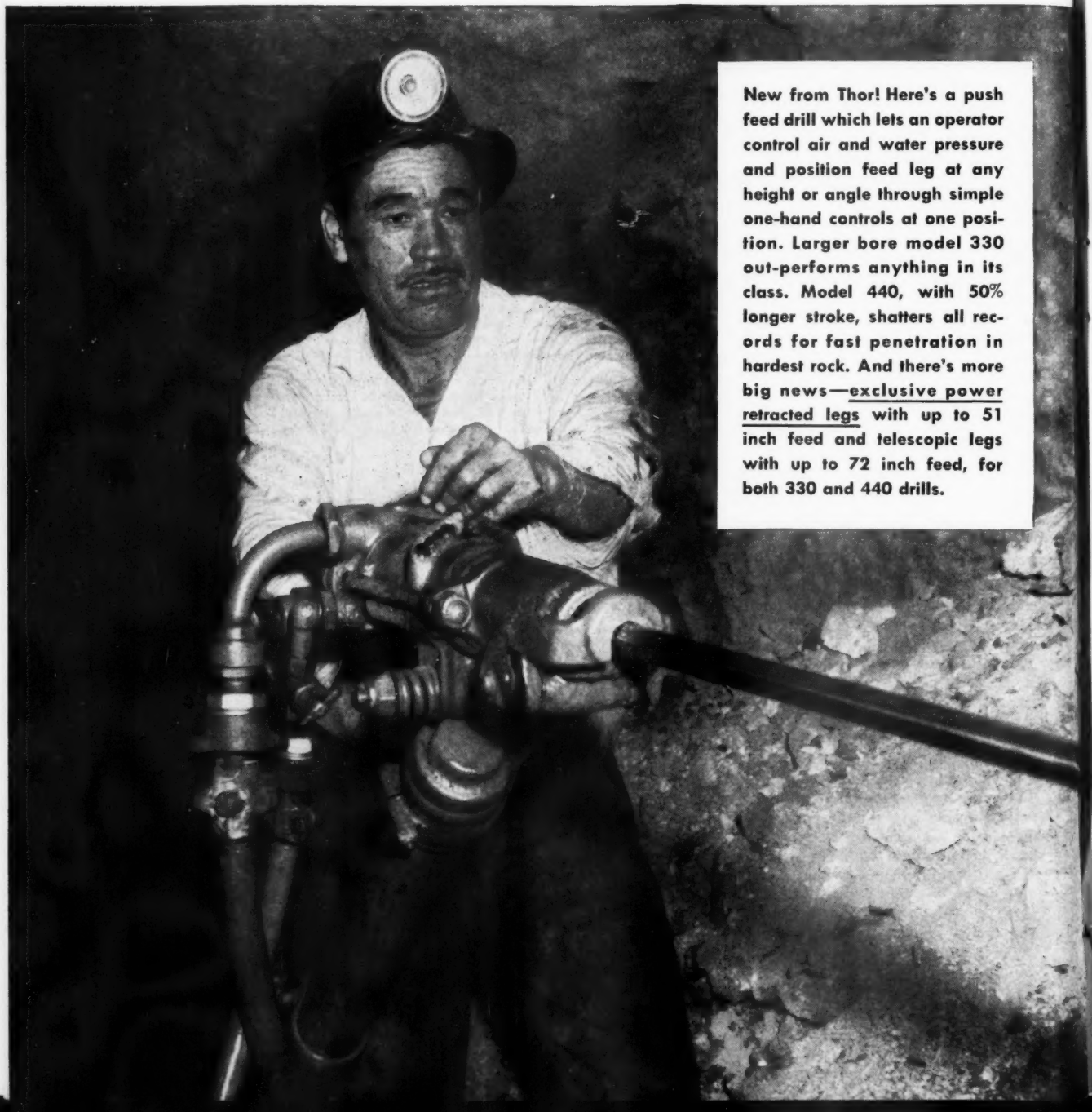
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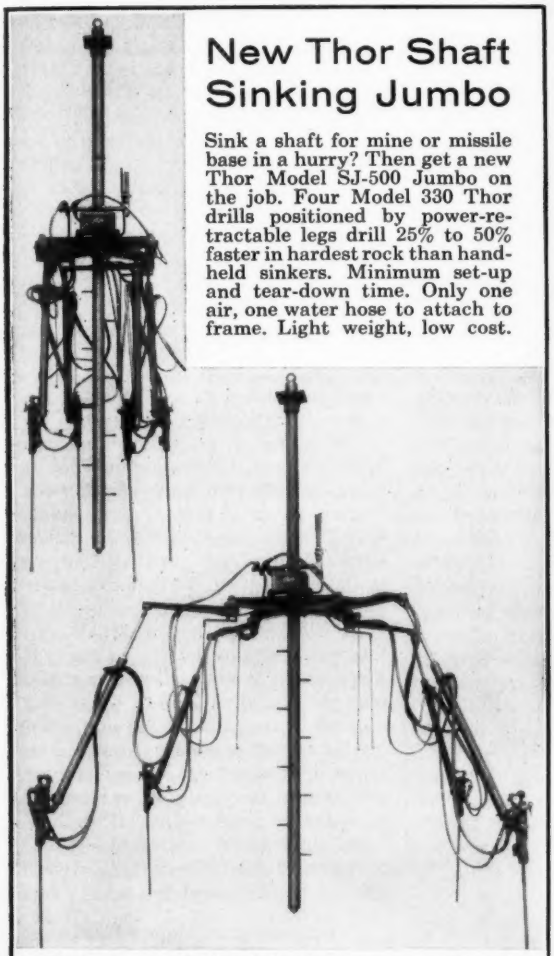
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Instrumentation and Automation of Plant Operation

By R. G. PATTERSON
Vice President, Manufacturing
California Portland Cement Co.

Centralized plant control is the ultimate goal of instrumentation and automation in the cement making process

THE first serious application by the California Portland Cement Co. of the concept of instrumentation and automation to plant operation was made in its Arizona plant in 1948. Original plant design specifications called for the control of kiln exit gas temperatures at the dust collection system by the automatic control of louvers in the kiln end housing, through which outside tempering air was to be introduced. The results attained were so rewarding that the application of this production tool in other areas was definitely indicated. During the next several years additional successful applications of instrumentation and automation were made in this plant, particularly in the burning phase of plant operations.

In 1954, while the company's Mojave plant was in the design stage, it was decided to study all phases of the planned operation and to apply our concept of instrumentation and automation wherever advantages could be realized. It was also decided to provide within the limits of our knowledge for possible additional applications which could contribute to progress toward the ultimate goal of centralized plant control.

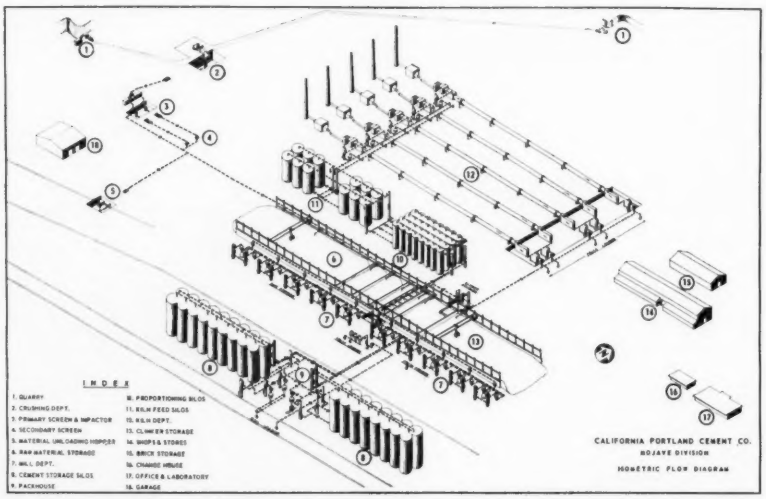


Fig. 1. The Mojave plant was originally designed to realize some of the benefits of instrumentation and automation, and to provide for additional applications that would contribute toward the ultimate goal of centralized plant control

Description of Mojave Plant

In this discussion the author will use the Mojave plant as an example of "Instrumentation and Automation of Plant Operations." The following description is a condensed picture of that plant's general arrangement (See figure 1).

The crushing department, which consists of three separate structures, is located at some distance from the crushed stone storage in order to take

advantage of the plant site topography. The primary crusher is located at a higher elevation than the secondary crusher, thus minimizing the height that the rock must be lifted from the primary crusher to the secondary crusher feed bins.

From these bins the material is fed by vibrating feeders to the primary screens which scalp off minus ¾-in. material for direct transfer to rock storage. Oversize material drops directly from the screens into the secondary crushers which are impactors. Belt conveyors carry the crushed material to the secondary screening structure and return the oversize material to the secondary crushers, thus forming a closed circuit. The passing minus ¾-in. material is combined with the minus ¾-in. material from the primary screens and is delivered by conveyor belt to a movable tripper which discharges along the north side of the storage building.

This storage is divided into crushed stone and clinker storage areas that are served by two 6-cu yd, 16-ton overhead cranes. Located in the center of the storage is a row of bins from which material is drawn and blended over weighing-type feeders to individual mill-feed bins.

The mill building houses ten duplicate mill circuits. Five of the circuits are for dry raw mix grinding and five are for finish cement grinding. However, the number one raw mill can be used also as a finishing mill when it is necessary.

The raw mix is conveyed to 32 proportioning silos and from these blended to 12 kiln feed silos. A further blend of the mix is then made from the kiln feed silos to the individual kiln feed bins from which the feed is metered by a constant head feed screw into the individual kilns.

Each of the five gas-fired kiln systems is a separate unit, including individual power circuits. The gases leaving the kiln enter the kiln-end housing where tempering air is added to control the temperature ahead of the mechanical collectors which are of the multiclone type. Following the "multiclones" is the main draft fan, which is a constant speed unit employing louvers for required draft control. The draft fan is followed by a four-section, three-unit electrostatic precipitator with final release to atmosphere through a 215-ft stack which provides negative draft across the precipitator and its inlet and outlet ducts.

The primary feed from the constant head feeder is blended with the dust reclaimed from the mechanical collector in the kiln feed screw. Precipitator dust at the present time is stockpiled. Clinker from each kiln is cooled in a grate-type cooler equipped with a chunk-breaker, weighed over a belt scale and conveyed to the clinker storage.

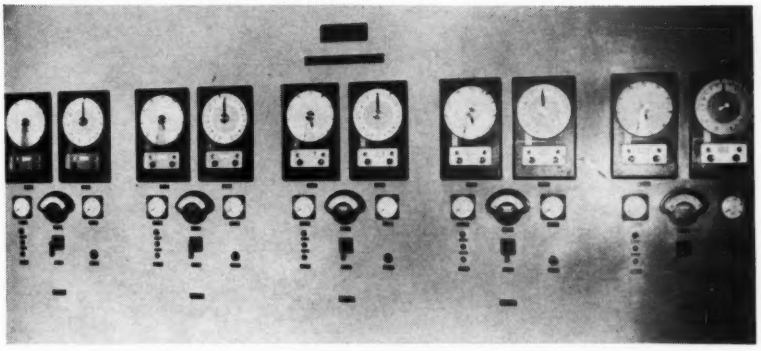


Fig. 2. Control panels for instruments in the mill circuits were designed to lend themselves to centralized control

After the clinker is ground into cement by the finishing mills, the cement is conveyed to any one of 52 silos, from which it can be conveyed to packer bin, bulk-truck loading, bulk-rail loading, any other silo or returned to the silo of origin.

Instrumentation and Automation Defined

Since the terms instrumentation and automation are generally used to cover broad fields, it is appropriate to define some of the terms of instrumentation and automation as used in our organization.

"Instrumentation" is defined as a combination of two elements, one of which is the sensing device (e.g., an ammeter, voltmeter, tachometer, generator, thermocouple, gas sampling tube, pressure or vacuum tap, etc.), and the other is the indicator, or recorder, or both combined, which translates the impulse from the sensor into standard units of measurement, such as amperes, volts, revolutions per unit of time, temperature, percent of oxygen, pressure in inches of water or mercury, relative positions of dampers or louvers, etc.

"Automation," the next step, is attained by the addition of a control element to the instrumentation first defined. By adjusting a set-point or combination of set-points within the controller, the mechanical or electrical device can then maintain an operating condition between upper and lower limits, or above or below a central limit predetermined and set by a human operator.

When one instrument with a control unit and a set-point controls and sets the set-point of a second instrument, we then have Two-stage Analog Control. This system is often termed Cascade Control.

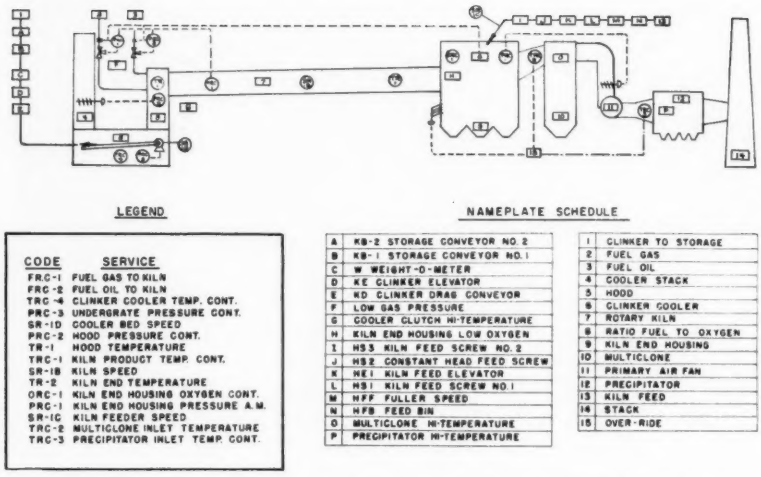
The next step beyond analog control, as defined earlier, is the digital computer containing a memory storage. This device can continuously store data and, in very short intervals, interpret the information fed into it; and, drawing upon its store of "memorized" data, instruct variations and make adjustments that are necessary for optimum process control—this in a fraction of the time that would be required by a human operator.

Moving Process Equipment Incorporates Interlocks

Actual implementation of the decisions made during the design of the plant will be considered as two phases; first the application of general controls, and second, the application of special controls.

Since the ultimate goal was centralized plant control, it was obvious that practically all plant operation would be outside the field of vision of the operator. Closed circuit television, supplemented by other indicating devices could overcome this limitation. Therefore, a TV monitoring system of eight cameras and six viewing screens was installed at the crusher. During the period this equipment has been in service, there have been several relocations of units, changes in lighting and development of methods for protection from dust, moisture and temperature variations. It is believed that the experience gained in this application will contribute materially to lower costs and improved effectiveness of additional installations.

A plant-wide telephone system installed and maintained by the serving utility is used only for general communication within the plant. A microphone and loudspeaker system, generally on a departmental basis, pro-



LEGEND

CODE	SERVICE
FRC-1	FUEL GAS TO KILN
FRC-2	FUEL OIL TO KILN
TRC-4	CLINKER COOLER TEMP. CONT.
PRC-3	UNDERGRATE PRESSURE CONT.
SR-1D	COOLER BED SPEED
PRC-2	HOOD PRESSURE CONT.
TR-1	HOOD TEMPERATURE
TRC-1	KILN PRODUCT TEMP. CONT.
SR-1B	KILN SPEED
TR-2	KILN END TEMPERATURE
ORC-1	KILN END HOUSING OXYGEN CONT.
PRC-1	KILN END HOUSING PRESSURE A.M.
SR-1C	KILN FEEDER SPEED
TRC-2	MULTICLONE INLET TEMPERATURE
TRC-3	PRECIPITATOR INLET TEMP. CONT.

NAMEPLATE SCHEDULE

A	KB-2 STORAGE CONVEYOR NO. 2
B	KB-1 STORAGE CONVEYOR NO. 1
C	W WEIGHT-O-METER
D	KE CLINKER ELEVATOR
E	KD CLINKER DRAG CONVEYOR
F	LOW GAS PRESSURE
G	COOLER CLUTCH HI-TEMPERATURE
H	KILN END HOUSING LOW OXYGEN
I	HS3 KILN FEED SCREW NO. 2
J	HS2 CONSTANT HEAD FEED SCREW
K	HE1 KILN FEED ELEVATOR
L	HS1 KILN FEED SCREW NO. 1
M	HFF FULLER SPEED
N	HFB FEED BIN
O	MULTICLONE HI-TEMPERATURE
P	PRECIPITATOR HI-TEMPERATURE

1	CLINKER TO STORAGE
2	FUEL GAS
3	FUEL OIL
4	COOLER STACK
5	HOOD
6	CLINKER COOLER
7	ROTARY KILN
8	RATIO FUEL TO OXYGEN
9	KILN END HOUSING
10	MULTICLONE
11	PRIMARY AIR FAN
12	PRECIPITATOR
13	KILN FEED
14	STACK
15	OVER-RIDE

Fig. 3. Proper air-to-fuel ratio and maximum heat recovery from the clinker cooler are essential to efficient kiln operation. Also, the temperature of the material immediately ahead of the burning zone must be maintained at an optimum predetermined level. To implement these concepts, instruments, automation and two-stage analog control systems were installed as depicted above

vides ready communication where high speed is a factor.

Flow rates in large operations, such as the Mojave plant, are in the hundreds of tons per hour and any failure, either mechanical or electrical, even though detected immediately by the operator, can result in substantial loss of production due to choked conveying equipment. A mechanical and electrical interlock system has been developed and is now in use on practically all moving process equipment at Mojave. In conjunction with this interlock system, there are audio-visual devices with alarms to alert operators to failures and with indicators to pin-point their locations.

Standard methods are employed to indicate when bins are full or empty. In many locations, such as mill feed bins, kiln feed bins, and dust bins, these methods are quite satisfactory. In the case of raw-mix blending silos, kiln-feed silos and cement silos, a system which indicates or possibly even records actual level of material in the silo would be preferred. The company is cooperating with several equipment vendors for final development of this type of equipment.

Control of bin filling for the individual mill circuits and kiln feed systems is automatic once the operator preselects point of origin and final point of delivery. This system was developed using proven standard components. Results have been quite satisfactory.

Special Controls Developed for Mill Circuits

The development of equipment and techniques for accurate and high-speed sampling for continuous analysis of all materials from the quarry to the finished product has been slow. Although actual progress in end results has not been at all what had been hoped for in this field, it has been possible to eliminate a number of approaches and develop those which promised the greatest return for the efforts put forth. The problem of reliable, accurate and high-speed sampling with delivery to the laboratory included must be resolved before complete centralized plant control can become a reality.

As a result, plans call for extreme concentration on this particular and often improperly evaluated phase of the over-all program.

Special controls were developed for the individual mill circuits at Mojave which consist of a feed bin, weighing feeder, the mill, discharge air slide, two elevators, two screw conveyors, and two 14-ft air separators. The mill discharge must be equally divided between the two separators. A splitter at the discharge end of the air slide is controlled by the amperage from the two separators. Results obtained with this installation are excellent—so good, in fact, that the same system is used to control the feed rate to the mill. The components employed in this control loop are proven standard units which have been used in the power generation and distribution industry for many years. The control panels for these instruments were designed to lend themselves to centralized control (figure 2).

Basic Concepts in Kiln Operations

In the kiln department the following concepts are considered basic. First, the proper air-to-fuel ratio and the maximum heat recovery from the clinker cooler are essential for efficient kiln operation. Second, the temperature of the material immediately ahead of the burning zone must be maintained at predetermined optimum values.

To implement these two fundamental concepts, instruments, automation, and two-stage analog control systems were installed (figure 3). Instrumentation is used to indicate fuel-oil pressure, fuel-gas pressure, instrument air-pressure, cooler over-and-under grate pressure, main-draft fan-louver position, tempering air-louver position, cooler excess air-damper position and amperage of all vital electrical drives, such as kiln drive, main draft fan, cooler fan and precipitator units. Instruments are also used to indicate and record burning-zone lining temperature, kiln exit-gas temperature, secondary air temperature and speeds of the kiln, feeder and cooler. All these values are indicated and recorded at the master control panel (figure 4).

Automatic control is obtained on the hood-draft by cooler stack damper movement, on the cooler speed by undergrate pressure and on the multiclone inlet temperature by tempering air louvers. The temperature of the precipitator overrides the multiclone temperature control. This override assumes control if the multiclone control fails to function. Both are equipped with a high-temperature limit to cut fuel at the burner to a pre-set minimum in case of excessive temperature.

Analog Loop Controls Oxygen in Kiln Exit Gases

The secondary air temperature instrument is equipped with control functions to permit weighing of the cooling air to the cooler undergrate chamber. We hope to complete tests on this equipment in the near future.

Oxygen in the kiln exit gases is controlled by an analog loop between the oxygen analyzer and the kiln draft controller. Both instruments indicate and record their respective values. A similar analog system is used to control product temperature by varying

the set-point of the fuel flow controller. The product temperature is measured 140 ft ahead of the burning zone. These instruments also indicate and record their respective values.

Two essential components in these systems are the Tel-O-Set and the Differential Pressure Cell. The Tel-O-Set is an instrument which receives a signal near its source, sends a control signal to the mechanical operating device and, simultaneously, sends a signal to the master control panel. The Differential Pressure Cell converts the difference in pressure, measured in inches of water or mercury across an orifice, into a 3–15 lb air signal which, in turn, activates a flow meter.

The product temperature loop was originally extended into the analog loop between oxygen and draft in order to pre-set the draft conditions with a change in fuel flow. Experience indicated this refinement of control was unnecessary.

A multi-stage analog computer which includes a multi-point recorder-controller is presently being developed. This system will make minor changes in kiln speed adjusting to changes in the rate of fuel flow. This is an attempt to maintain actual initial clinkering at the same point in the kiln at all times.

Maintenance of Instruments and Control Devices

Maintenance in general is limited to cleaning, oiling, and routine replacement of batteries and tubes. Complete checks and service are made when the kiln is down for reline. Replacements of some of the mechanical and electrical moving parts have been found necessary at approximately two-year intervals. The two-stage analog controls have required more maintenance and supervision than the straight-line controls—this being caused by slower evaluation of the problem due to the greater number of components. In the oxygen-draft system causes of failures have now been resolved. The oxygen analyzer is quite sensitive to temperature and sample humidity. The addition of temperature control has essentially eliminated functional failures in this system.

In the product temperature control system all of the equipment has functioned very well, but continuous operation has been delayed by the search for satisfactory thermocouples in the kiln shell. It is believed that the solution to this problem is near; however, the period of service is not adequate at this date to permit making a positive statement.

Centralized Plant Control is Believed Attainable

Experience at Mojave with the various application of instrumentation and automation has provided a wealth of information from which the following conclusions have been made:

The use of instrumentation improves the process by, in effect, extending the senses of the operator. The proper use of instrumentation provides the operator with data which he can evaluate to carry on the process within closer limits than possible without such data.

With the addition of control to the instrumentation we can more closely and continuously guide the process and free the operator from making routine adjustments. Thus the operator is provided additional time to approach the desired optimum through a more thorough evaluation of long-range changes which lie outside the range of instrumentation with simple control.

With the addition of analog loops to a system of instrumentation, a larger number of changes are made routine, again reducing the adjustments to be made by the operator and providing additional time for over-all process evaluations.

Instrumentation, automation and analog systems with their various mechanical and electrical devices will do a profitable job, and it is felt that the coming of centralized plant control is only a matter of time and perseverance.

However, before being accused of painting a one-sided and unduly rosy picture, let it be said that these goals are attained only by the payment of a price which must be recognized in advance or all the capital investment required for such an installation will be wasted.

Importance of Having Trained Personnel

An installation which includes instrumentation, automation and analog systems with possible centralized control, demands personnel who understand the equipment, its limitations, and the process which is to be controlled. These technical people must be provided with technicians, instrument maintenance men and electricians with some knowledge of electronic devices. Continuous training of operating personnel in the functioning of the equipment with emphasis on the range of its capabilities and limitations is mandatory. This training repeatedly pays for itself since understanding on the part of operating personnel continues to indicate the paths of further exploitation of gain by minor modifications for reasonable additional costs.

We are convinced that ultimate centralized plant control will be the product of logical development along the general lines followed to date. Once we have learned to properly apply instrumentation and automation, and have arrived at centralized plant control supervised by trained technical people, it is felt that the rewards will cover a wide field. Productivity per operating hour will be increased and stabilized; consumption per unit of production of expendable items, such as grinding media, mill liners, refractory linings, fuel, power, etc., will be greatly improved; chemical and physical properties of the end product will be more uniform.

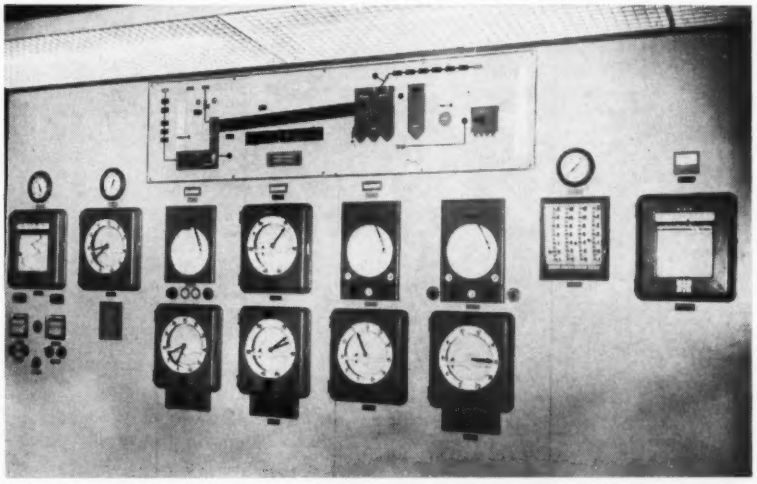


Fig. 4. Applications of instrumentation and automation at the Mojave plant have been particularly successful in the burning phase of operations. Shown are the indicating and recording devices on a kiln master control panel

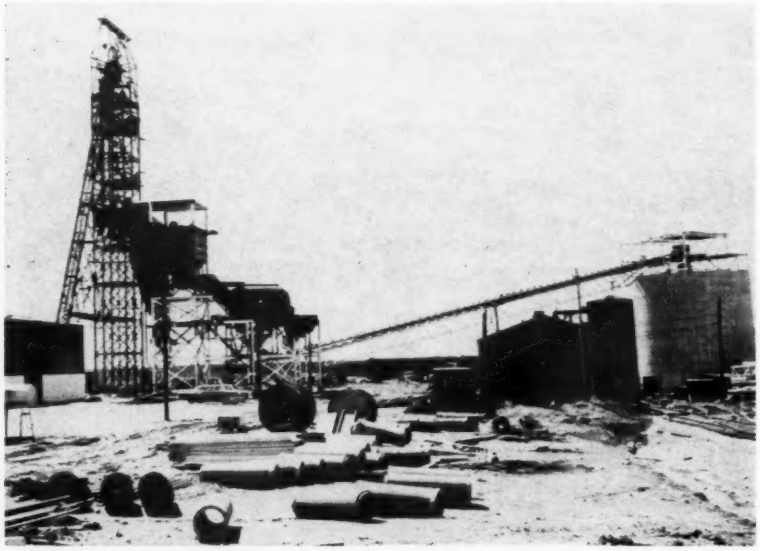
Orient Mine No. 5

Freeman Coal Mining Corp. is stressing automation, concentration and modern coal preparation in its new 7500 tpd mine in Illinois

By THOMAS L. GARWOOD
Chief Engineer
Freeman Coal Mining Corp.

COAL reserves for Orient Mine No. 5 were secured early in the 1900s by Chicago, Wilmington & Franklin Coal Co., and taken over together with the company's other properties by Freeman Coal Mining Corp. about eight years ago. Since that time several of Freeman's mines have been worked out, and it became necessary to look to the opening of a new mine for continued tonnage for the market.

The decision to do this was made final rather quickly and very little detailed study toward the design of a particular mine had been made. No final design or system had been decided on to prepare the coal nor had methods for working underground been researched. The company has had considerable experience in various methods and processes and it was first thought proper to utilize these current procedures. Tentative understandings had been in existence for a long time regarding the limits for mining and it was thought no trouble would be forthcoming in straightening the boundaries with neighbors.



The main shaft headframe for the 7500 tpd mine is well on the way to completion, and the rotary breaker, rock chutes and conveyor to the 3600-ton storage silo will be ready for operation before the preparation plant is built

Plant location was a natural, adjacent to the railroad, with slopes in the proper direction and location for reservoirs adjacent to the mine site, ready for clearing and construction. Underground conditions were pretty well known through experience of those who had mined the surrounding areas. Sounds easy, doesn't it?

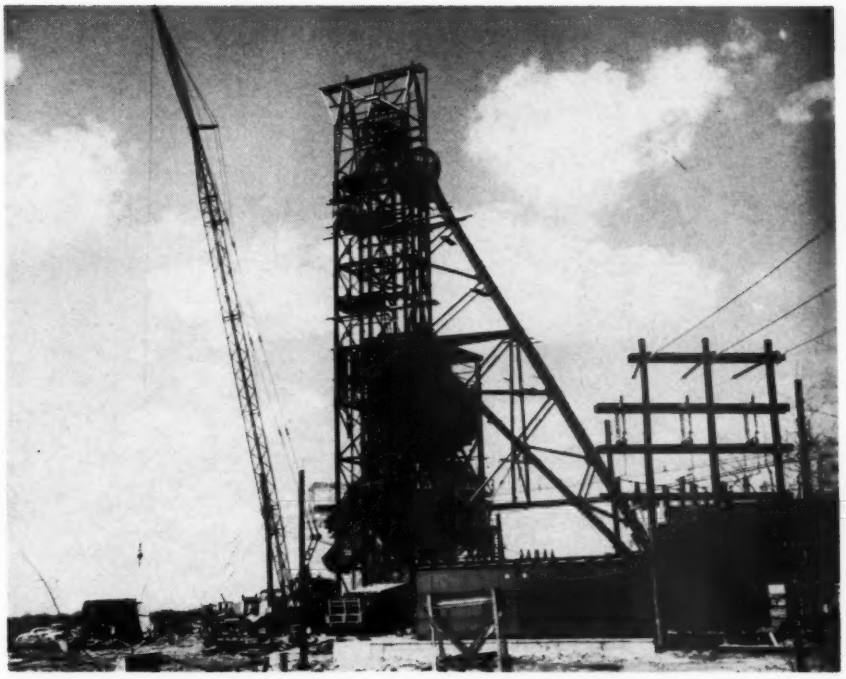
Plans were made and drilling started to obtain data for shaft sinking. Ground was cleared and plans for the surface layout and buildings started. In the clearing, a group of trees were noted that seemed to have a particular arrangement, then a few pieces of stone with indications that they were neither natural nor native. Piecing these together as you would a puzzle showed carving and dates. The company had uncovered a burial ground right in the middle of its track layout. It was not listed in any land description nor shown on any map but was recalled by a very old lady who had been present in her very early childhood at the funeral of her grandfather.

Luckily, actual construction or sinking had not been started, and a new plan was chosen. Locations of the two shafts were moved and the yard layout practically flipped over to allow the by-passing of the burial plot. The natural grade necessary for a gravity yard was not only still present but somewhat accented and considerable extra grading was necessary to reach an acceptable layout.

Modern Mining—Key to Design of Mine

Modern mining is to be the key in the design of this mine: automation as far as possible, concentration as far as practical, processing as up to date as the future market indicates and emphasis on minimizing manpower requirements.

Location of the shaft bottom is as near the center of the property as combinations of physical and natural conditions permit. It was decided to lay out the mine so that it can be worked in quarters. The northwest section is planned to be worked out first since the boundaries are well fixed in that portion of the mine. Probably the order then will be the southwest, the northeast and finally the southeast section because it is indicated as the most pliable, possibly the most varied and maybe the most questionable as to mining characteristics but not at all hopeless. At first it had been thought that conventional methods using the undercutter, airshooting and mobile loader might be



Another view of the main shaft headframe with the incoming power substation and control in right foreground. The shaft bottom and the coal hoist are designed to operate automatically but in an emergency can be controlled by the dispatcher at the rotary dump

the system employed, but with the company's 32 years' experience with the twin-boring machine in the mine nearest this location, it was thought necessary that this be tested here. Development is now going forward, using this type of machine.

Part of Work Contracted to Speed Completion

Realizing that the company could not handle this work alone and have the mine in production within the time management hoped it could be, it was elected to have portions of the job done by specialized contractors. Grading, building and shaft sinking were started immediately and the preparation flow-plan selected. Designs for the preparation plant were started in the order in which the facility was to be erected. Trackwork was ordered to be constructed by Illinois Central Railroad crews who have the experience, the men, and the equipment and are normally doing this type of work.

Headframes were available from a recently abandoned mine that had a very short life. Hoists that had never been installed were found available and ideally suited to the design of the new plant. One of these is now working at the man and material shaft and while it is now being manually controlled during the development period, it will be automated in the very near future for regular service later. A temporary dump arrangement was made to handle the first coal mined in development and until the main coal hoist can be set in operation. While the speed with which coal can be hoisted now is compatible with primary development, it is not up to the capacity that the company wants. As soon as the area for expanded production is available, the greater capacity of the regular coal hoist will be utilized to hoist the production of added crews.

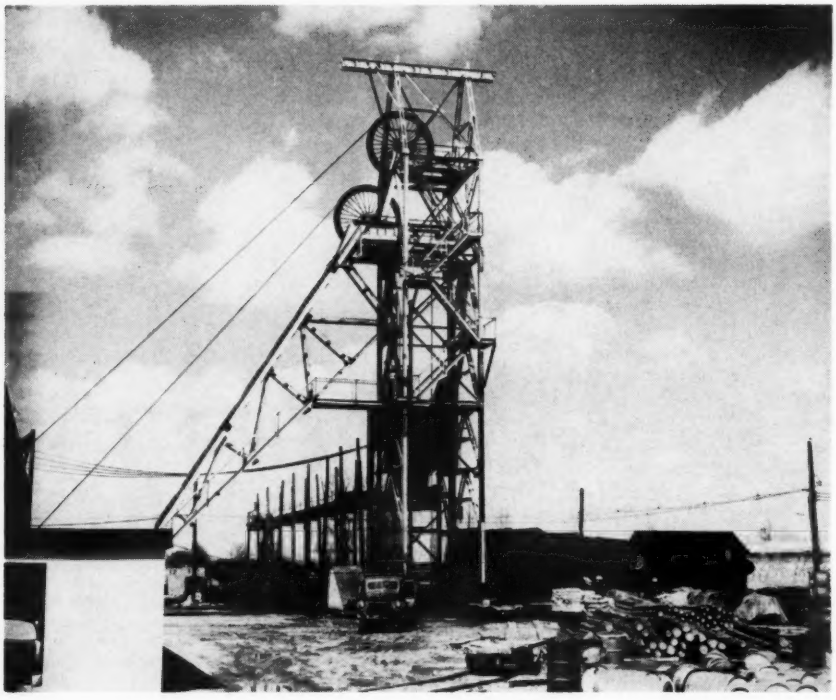
Coal now being mined is being sent to Freeman's No. 4 mine for processing on the off-shift, and it is hoped the arrangement will continue with sufficient capacity to take care of the coal until the new mine's own preparation plant is constructed.

The main building on the surface is a continuous unit in that both hoists, all shops, the office, supply room, boiler room and washhouses are under one roof, completely fire-proof and arranged in a manner most acceptable and for efficient operation. Men will travel underground from the washhouse to the shaft and will not be exposed to the weather at any time. One steel building, separated from the main unit and used for construction housing, will be used to store staple supplies, and a garage will probably be constructed apart from these for use by the various trucks.

The coal hoist headframe is well on the way to completion, and the rotary breaker, rock chutes and conveyor to the 3600-ton storage silo will be ready for operation prior to the building of the preparation plant. A conveyor, similar to the one in use at the man and material hoist which is now being employed for first development, is in the process of erection and will handle the coal hoisted at the coal hoist during the accelerated development by additional crews working in separate areas. At the loading point, the coal will pass over a vibrating screen to separate the minus ¼-in. coal from the 3½ by ¼-in. to assist the No. 4 plant to process greater tonnages. The minus ¼-in. coal has been found to be of sufficiently low ash to be handled directly by utilities. This screening equipment, which has been erected on a temporary basis only, will remain in place after the completion of the preparation plant only long enough to allow the "debugging" after which it will be removed.

Coarser Sizes Will Be Treated in Dense Medium Cells

Processing will be done in a McNally-Pittsburg designed plant with the coarser sizes (3½ by ¼-in.) being treated in dense-medium cells and the smaller coals tabled for final treatment of the mine-run coal. Dewatering and heat dryers will be employed to make the product ready for loading. Coal will be sized in the final stages to predetermined increments. Each size will be placed on a separate



Man and material headframe. Men will travel underground from the washhouse to the shaft and will not be exposed to the weather at any time

conveyor, all passing over another group at right-angles to the first. Coal from the top group can be dropped through motorized gates onto any conveyor of the lower set in combinations to meet the special market demands, and loaded into any class car as per sales instruction. Any excess tonnage of the small size coal may be passed onto or picked up from a storage pile for loading as such or for combining with other sizes on any track.

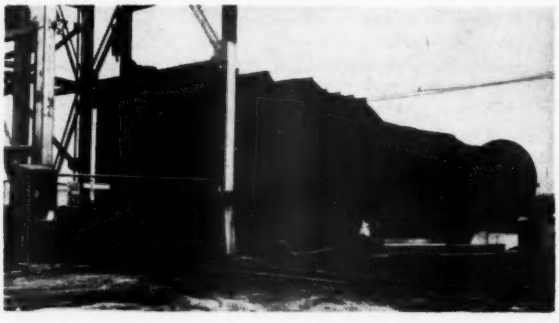
Control of these gates and the loading will be handled by the operator in the loading tower. This fellow will be a busy man. He will compare with the dispatcher or control man in any large power plant. He will know the operation of the preparation plant, the desired loading both as to size combination and the car to receive such coal and will by control of mixing gates place the required mixture in whatever car he so chooses. It is intended that he will take the data from each car—initial weight, tare weight, and size of coal—and place this information in a "memory unit." Upon completion of the loading of each car it will be released, pass by gravity through a retarder and by a rail contact switch indicate to the memory unit the gross weight determined when passing over the electronic scales. The total record will be sent to the billing department for handling. The car will then pass on by gravity into the load yard to await pick-up by the railroad as per instructions from the billing supervisor.

Haulage System Includes Belt, Track, and Skips

Underground the coal will be mined according to design in as near complete recovery as conditions will permit and be carried out of the mining area via belt to an automatic loading station where it will be placed in 15-ton eight-wheel mine cars for transportation to the bottom. It is planned to use two 20-ton locomotives in tandem to handle these trips. The bottom is so arranged that the trip is turned around and backed onto the load-track, coupled automatically and moved by car-haul onto a rotary dump. Half of each load will pass into separate pockets making up alternate skip-loads of 15 tons in each of two loading chutes. The bottom and the coal hoist are designed to operate automatically but subject to an emergency stop by the dispatcher at the rotary dump.

Ventilation is based on a blowing system with the possibility of release through upcast shafts to be sunk later at the corners of the property. This will minimize the air which must be returned to the hoisting shafts and permit fresh air to be used on the haulage.

The plant is scheduled to produce 7500 tpd of cleaned coal in a two-shift operation, with a maintenance shift taking care of the repair, lubrication and adjustment of the equipment. Should a demand be made for greater production, the company can draw on built-in extra capacity to meet the request. To date the company has an acreage of 6874 assigned to the mine, which should provide an expected life of better than 30 years.



The mine will be ventilated by a pressure system





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EUCLID

DIVISION OF GENERAL MOTORS, HUDSON, OHIO

Plants at Cleveland and Hudson, Ohio and Lanarkshire, Scotland

Dustless Breaking of Rocks Electrically

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* *Translated expressly for Mining Congress Journal from GORNYY ZHURNAL (Mining Journal), September 1960, by Royer and Roger, Inc., Washington, D. C.*

A new method for secondary breaking of hard iron ores electrically was developed in the Laboratory for the Application of Electrical Technology in Mining at the Institute of Mining of the Academy of Sciences of the USSR. This procedure, in addition to being dustless, is cheaper and safer (owing to the absence of flying fragments) than blasting.

The phenomenon of thermal breakthrough constitutes the physical basis of the new method of rock-breaking. Thermal break-through occurs when voltage is supplied through point electrodes from a source of current of definite frequency to a lump of rock (semi-conductor or dielectric). Because a nonuniform electric field forms between the sharp electrodes, the rock heats up in the zone surrounding the contact with the electrodes while the interior temperature remains practically unchanged. Intensive heating changes the rock under the electrodes into a conductor, giving the effect of immersing the electrodes into the rock and diminishing the distance between them.

Rock Breaks Under Influence of Temperature Stresses

Zones of elevated temperature and high conductivity appear in a rock of inhomogeneous composition at not only the electrodes, but also at depth in the region between the contacts. The elevated temperature zones expand rapidly, one toward another. A break-through takes place when a current-conducting channel is formed between the electrodes. The strength of the current and the release of heat in this channel increase considerably and the rock breaks up under the influence of temperature stresses.

Conditions required for the formation of current-conducting channels vary for different rocks. They are particularly favorable in iron ores (semiconductors) with low initial resistance (tens to hundreds ohm/cm) and less so in large lumps of rock (dielectrics) (hundreds of millions ohm/cm).

The resistivity of different ores and rocks decreases in varying degrees as the temperature rises. Thus, in a sample of Tashtagol'sk iron ore a rise in temperature from 20° to 200° C results in a drop of resistivity from 40 to 5.2 ohm/cm, i.e. by a factor of almost 8. Heating of Aktyubinsk chromites from 20° to 200° C produces reduction of resistivity from 400 to 13 mohm/cm, and at 600° C, a drop to 1.6 mohm/cm.

The electric resistance of rocks also diminishes with growing electric field strength and frequency. For the Tashtagol'sk magnetites an increase in the electric field strength between the contacts from 4 to 25 v/cm causes the resistivity to drop from 40 to 8 ohm/cm, i.e. a five-fold reduction. For the Tyrnyauzsky skarns a rise in frequency of the electric field from 0.2 to 10 megs results in a four-fold drop in effective active resistance—from 10 to 2.5 kohm/m. At a frequency of 120-megs it shows a drop to 0.6 kohm/m, or a reduction by a factor of 16–17. At 8-megs frequency the effective active resistance in samples of Aktyubinsk chromite ore was registered at 150 kohm/cm at 60° C, 37 kohm/cm at 240° C, and 7 kohm/cm at 300° C. A further rise in temperature leads to a sharp reduction in resistivity (to a break-through).

Thus, the frequency and strength of the electric field, and the temperature of the rock, constitute the main factors determining the formation of a current-conducting channel in a rock sample. The appearance of a current-conducting channel in a rock is easily detected with the aid of a source of continuous current. The formation of a current-conducting channel results in the localization of the energy released within the rock in the narrow channel zone. This, then, constitutes the main factor responsible for intensification of the break-up process.

Methods of Imposing Electric Currents

On the basis of the formation of current-conducting channels, it is possible to propose the following variants for a new electric rock-breaking method:

1) high-frequency contact method, whereby one and the same high-frequency oscillator is used to form a current-conducting channel and to impose a high-power discharge through the channel to raise the temperature and break up the rock;

2) combined method, whereby a current-conducting channel is formed with the aid of a high-frequency current source, while the subsequent heating and breakage are brought about by the action of a high and low-frequency current source (including 50-cycle current or direct current);

3) combined high-frequency pulse method, in which the rock is broken up by a pulse of electricity discharged from a capacitor into the current-conducting channel formed by the high-frequency current.

Figure 1 shows the basic circuitry of an assembly used in the high-frequency contact method of rock breaking. It includes a high-frequency vacuum-tube generator oscillation circuit in which C_1 is the circuit capacitance, L is its inductance, and C_2 is an isolating capacator. The electrodes are connected to the generator load circuit by a coaxial high-frequency cable. The high-frequency oscillator must be equipped with a special device to automatically control the oscillator tube when the load changes as the current-conducting channel is formed, and the rock is broken.

The formation of a low-resistance current-conducting channel with high-frequency current permits the use of cheaper types of electric power: including both direct and commercial

Table 1. Results of tests on the breaking of ferruginous quartzites through application of the high-frequency contact method at the opencast workings of YuGOK (Southern Mining and Concentration Combine)*

Weight of lump metric tons	Distance between the contacts, cm	Time of breakthrough, sec	Time of breaking up, sec	Number of large lumps after breakup, pieces	Energy consumed, kwh
up to 0.5	30– 40	up to 1	5– 20	3–8	0.1–0.3
0.5– 1.5	50– 60	1– 5	30– 40	3–5	0.5–0.8
1.5– 5.0	60– 80	3– 7	30– 90	3–5	0.5–1.5
5.0–10.0	70–120	5–10	60–180	3–4	1.0–3.0

** In all tests the breakthrough voltage was equal to 1000–1200 v. Voltage after the breakthrough was 300–500 v and the current after the breakthrough 60–80 amp.*

frequency currents. [Editor's Note: The common commercial frequency in Russia is 50 cycles.] A circuit for such an approach, the combined method or rock breaking, is shown in figure 2. The circuit consists of a high-frequency assembly, a source of direct current—or high-power, high-voltage commercial-frequency current—and filters, L_2 and C_2 which are designed to preclude the penetration of high-frequency currents into the rectifier, as well as to prevent the direct current—or the commercial-frequency current—from entering the high-frequency oscillator.

At the initial stage of the breaking process, while the resistance is still great, most of the energy comes from the high-frequency oscillator. As the rock is heated and resistance decrease, more of the energy is supplied by the direct current (or commercial-frequency current) source. After a current-conducting channel is made, the proportion of current from the second source begins to grow rapidly. This may serve as a signal to switch off the high-frequency oscillator.

In a similar way a capacitor discharge may be used to break the rock after a current-conducting channel is created by high-frequency current. The basic circuit for the combined high-frequency pulse method is illustrated in figure 3. The current-conducting channel in the rock is formed with high-frequency current. High-frequency current is delivered to the upper contact of a change-over device. A high-voltage gang capacitor is connected to the lower contact. At the beginning of the process high-frequency voltage is supplied from the generator to the electrodes contacting the rock. At the same time, the high-voltage rectifier, which consists of a high-tension transformer and high-voltage kenotron K, charges gang capacitor C_2 across resistor R. After a current-conducting channel is made in the rock, the switching device disconnects the high-frequency oscillator and switches to the capacitor unit which supplies the high-voltage pulse that breaks the rock.

The results of preliminary tests justify the assumption that this method will be effective for breaking tough rocks. The combined methods of breaking oversized lumps make it possible to reduce the costs of power and equipment, since they require a lower output of the assembly's high-frequency component.

Ore Lumps Weighing Up to 15 Tons Broken

Experience shows that the ferruginous quartzites of the KMA (Kursk Magnetic Anomaly) and Krivoy Rog may be broken up not only by high-frequency currents, but also by 50-cycle alternating current. However, the voltages (700–1300 v) involved are dangerous and call for the development of special safety measures. Moreover, when low-frequency currents are used, the electric method becomes selective and the rock is broken only when the contacts are located in a definite position in relation to the rock layers.

Results obtained while testing the high-frequency contact method proper, led to experiments on the breaking of large lumps of iron ore at the Southern Mining and Concentration Combine in 1958. The experimental unit was built from a piece of equipment (LPGZ-60) having a 60-kw oscillation output and an operating frequency of 250 kc/s.

Necessary alterations were made in the LGPZ-60 unit circuit (see figure 4). To step up high-frequency voltage the number of loops of the high-frequency transformer secondary winding L_{11} was increased from one to three (in some experiments to seven). The inductor L_{10} was disconnected and, in order to preserve the natural frequency of the load circuit (C_{10}, L_8, L_{11}) its capacitance was reduced by 15–20 percent. To coordinate the operating conditions of the oscillator tube with the load, a fixed connection was experimentally selec-

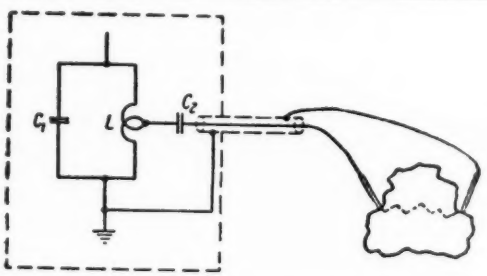


Fig. 1. Basic diagram of a high-frequency assembly for breaking oversized lumps by the contact method

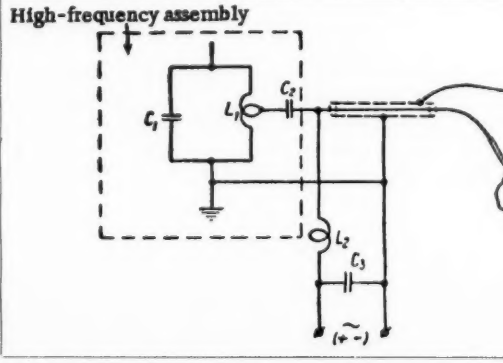


Fig. 2. Basic diagram of high- and low-frequency assembly for rock breaking

ted of the plate and load circuits (the mean inductance point L_8).

High-voltage was supplied to the ore lump from transformer L_8 L_{11} through a 25-m long coaxial cable of the RKG-10/10 type. Altogether, 200 tests were carried out. Experimental results are listed in table 1.

In all cases a thermal breakthrough was achieved and the ore lumps (including some weighing up to 15 tons) were broken. Channel depths reached as much as 1.2 m. The tests showed that, at 1.0 to 1.2 kv voltage and 250-Kc/s frequency, the time required for the formation of a current-conducting channel was 10 sec. The current flowing through a lump of ore, after the breakthrough, increases six to eight times up to a ceiling of 60 to 80 amp. Voltage on working electrodes drops down to 300–500 v after the breakthrough. The breaking time for lumps weighting from 0.5 to 10 tons varied from 5 to 180 seconds, with the consumption of energy ranging from 0.1 to 3.0 kwh.

Cheaper Than Secondary Blasting

In 1959 at the YuGOK open pit mine a special high-frequency mobile unit for secondary breaking of iron ores was tested under operating conditions. The unit was constructed by the Dnepropetrovsk Mining Institute and the YuGOK from data furnished by the Institute of Mining of the Soviet Academy of Sciences. Altogether 55 tests were run. Chunks of iron ore weighing from 200 to 15,000 kg were subjected to breaking. As a rule, from 30 to 180 seconds were required to break a lump.

Experimental and industrial checking of the high-frequency contact method for secondary breaking of iron ores confirmed the high degree of efficiency of this method in breaking up chunks of ferruginous quartzites. According to tentative estimates, the cost of reducing oversized lumps by the high-frequency contact method in underground mines is 0.4–0.5 rubles per ton, or 5–6 times cheaper than secondary breaking with explosives, and 20–25 times cheaper than secondary blasting at the YuGOK open pit mine.

Practical data for the development of the first commercial model of the unit were obtained as a result of these experiments. It was established that it is more expedient to build two separate mobile units: a power unit including the anode transformer and rectifier, and an oscillator unit with cable outlet and tongs.

The power input into the rock should range from 50 to 70 kw; the length of the flexible high-frequency cable may be 150 m.

In 1959, investigation of the high-frequency contact method of rock breaking was continued at the Institute of Mines of the Soviet Academy of Sciences and applied to magnetic and hematite iron ores.

The possibility of a thermal breakthrough and the formation of a current-conducting channel and break up of tough magnetic ores containing 20 to 80 percent of magnetite and hematite was explored. Tests were carried out at frequencies ranging from 230 to 270 kc/s and 1.0 to 2.5 kv voltage at the electrodes. The breakthrough distance varied within the limits of 100 to 700 mm. A current-conducting channel was made in all cases. The time needed to establish a thermal breakthrough fluctuated between 1.0 and 16 seconds.

An experimental industrial unit was developed to estimate the breakability of lumps of tough magnetic and hematite iron ores. Laboratory tests on samples of moderate size lumps ($700 \times 600 \times 600$ mm) of tough iron ores show that their reduction calls for greater power than is required for breaking ferruginous quartzites.

Disadvantages of Method Noted

The practical application of the high-frequency method of breaking oversized rocks poses a number of difficulties. In breaking up large lumps of ore hanging in discharge hoppers, certain chunks may not be broken into chunks small enough to flow through the hopper. In opencast workings care must be taken to eliminate radio interferences caused by additional frequencies arising during the operation of the unit.

A substantial drawback in the high-frequency contact method occurred when breaking ferruginous ores having low contents of current-conducting minerals or when working with delectric rocks. This defect exists because of the selectivity of the method: whenever the electrophysical properties of a rock change, it is necessary to change the parameters of the high-frequency oscillator, primarily its frequency and the voltage on the working electrodes. Thus, for breaking dielectric rocks these values must be higher than in the case of ores of the semi-conductor type.

On the basis of the scientific and technical data produced by the Institute of Mining of the Soviet Academy of Sciences the electrical industry is presently engaged in developing the first experimental-industrial models of high-frequency units for secondary breaking of iron ores in both deep and opencast mines.

Inquiries into the influences of the electro - magnetic high - frequency fields, pulse discharges, and other physical forces on various rocks open up new prospects in the perfection of the technology breaking rocks electrically.

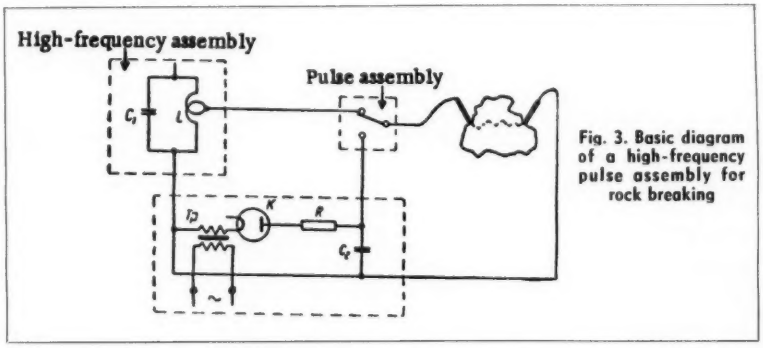


Fig. 3. Basic diagram of a high-frequency pulse assembly for rock breaking

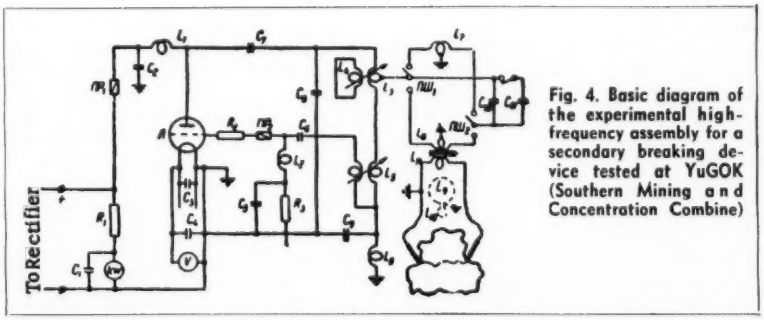
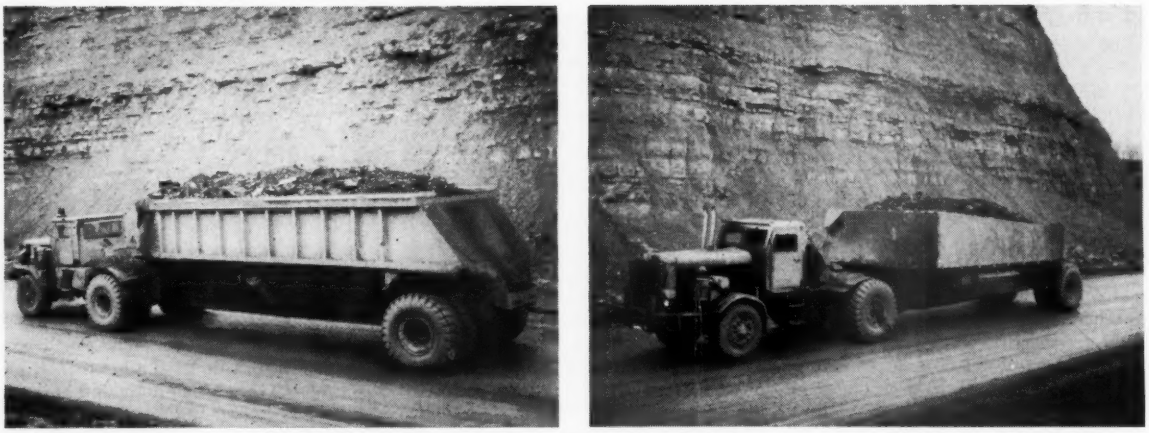


Fig. 4. Basic diagram of the experimental high-frequency assembly for a secondary breaking device tested at YuGOK (Southern Mining and Concentration Combine)



Two types of 50-ton units that are being used. Since 1953 the company has cut its haulage cost per ton-mile 14.5 percent by going to 40-ton and larger coal haulers

Economics of large versus small Haulage Units

Coal haulers, 40 tons and over, have proven to be the most economical for Central Ohio Coal Co.

By E. F. ECKHARDT
Manager of Coal Mining
American Electric Power
Service Corp.

CENTRAL Ohio Coal Co., a wholly owned subsidiary of Ohio Power Co., which is part of the American Electric Power Co. System, has strip mines operating in the vicinity of Zanesville, Ohio, for the purpose of producing a portion of the coal used at the Philo and Muskingum River generating stations of Ohio Power.

Central Ohio Coal has been operating in the Meigs Creek No. 9 and Ohio No. 6 coal seams using the contour method of strip mining. Since the company's inception, approximately 15 years ago, approximately 110,000,000 ton-miles of truck haulage has taken place using units which ranged from 20 to 70 tons in size and the average operating cost has been $0.047 per ton-mile.

The company operated the East Fultonham mine, better known as Philo No. 2 mine, also the Cumberland No. 3 mine and the Muskingum mine. The Philo No. 2 mine located near East Fultonham, Ohio, ceased operating during 1959 after depleting its total reserves. The other two mines are operating in the Meigs Creek No. 9 coal field.

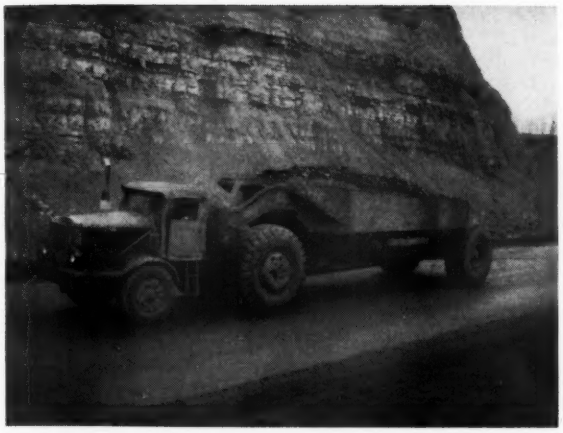
Haulage—A Major Factor in Operating Cost of Three Mines

Because all of the coal produced by Central Ohio Coal has been transported from the operating pits to the preparation plants by drop bottom coal haulers, it is easy to see why the company is interested in securing the best available and most economical truck transportation cost and will always be interested in obtaining the most economical transportation method available.

Philo No. 2 operation mined 6,000,000 tons of Ohio No. 6 coal and the maximum haulage distance was 3.6 miles and averaged 2.2 miles. This resulted in hauling approximately 13,200,000 ton-miles to deplete the field. This entire field was mined using 20-ton haulage units at an average cost of $0.053 per ton-mile.

The Meigs Creek No. 9 coal field which has been allocated to two operating mines covers an area 20 miles long and 5 miles wide or 100 square miles and contains estimated reserves of approximately 54,000,000 tons of recoverable strip coal based on the present rate of recovery. The total amount of haulage required to mine this field will amount to approximately 500,000,000 ton-miles and take approximately 20 years to deplete based on the present method of mining and rate of production.

Because the two mines working the Meigs Creek No. 9 seam are continually advancing their haulage distances



As part of its preventive maintenance program, Central Ohio Coal Co. has always built and maintained its haulroads with a minimum grade

in a northerly direction at the rate of approximately ½ to ¾ of a mile per year, Central Ohio Coal has always had a major haulage problem and will continue to have this problem until the two operating mines are depleted.

Therefore since haulage is a major problem and definitely a major factor in the operating cost of the mines, this article will attempt to show how Central Ohio has tried to answer its haulage problems.

Of course, what applies to Central Ohio may not apply to other operations because conditions and requirements are not the same. Furthermore, the writer does not want to say that other methods of transportation are not economical because Central Ohio, along with other companies, is in the process of making studies about other methods of transportation from the pit to the preparation plant. However, for these particular operations the company feels that using the largest trucks available has proven to be the best and most efficient method of transportation to date.

$0.053 per Ton-Mile Obtained With Nine 20-Ton Units

The haulage trends at Central Ohio Coal started back in 1947 when the previously mentioned Philo No. 2 operation purchased 20-ton bottom dump coal haulers to operate in the Ohio No. 6 coal field and designed all facilities accordingly. Because there were no larger bottom dump coal haulers available at this time, the company feels that the pattern which was to be continued throughout the life of the operation was set at this time and that was to use the largest haulage unit available which would be applicable to its mining conditions and requirements.

The 20-ton units were equipped with Cummins 6 HB diesel engines having a rated horsepower of 150 and when empty weighed 36,000 lb. The engines were later changed to NH series, 200 hp. Furthermore these units were furnished with 21:00 by 24:00 by 20 ply single tires on the tractor drive and trailer which were requested by the purchaser. The single tires were requested because the company felt that a better floating action would be obtained resulting in less spin and reduced wear. This theory was verified because the tire cost per ton-mile averaged $0.009 which was very economical when compared with larger units.

During the 14 years the Philo No. 2 mine operated, it used nine haulage units to haul 13,200,000 ton-miles and the average cost amounted to $0.053 per ton-mile.

New Mine Purchases 40-Ton Coal Haulers

During the above mentioned period Central Ohio developed the Cumberland No. 3 mine in the vicinity of Cumberland, Ohio. This mine was developed to work the Meigs Creek No. 9 coal seam which averaged approximately 48 in. in thickness and had an average overburden height of 52 ft. It was operated by a contractor from 1947 to 1955 and after 1955 by Central Ohio Coal.

The new mine's railroad loading facilities which transported the coal to the Philo plant were located in the extreme southeast corner of the field, which meant that the maximum haulage distance to complete the mining of this field would be 12 miles. Also, the tonnage requirement would amount to double the previous mine output. Thus, it was imperative that the most economical haulage units available be purchased for this operation. Therefore, the company purchased six 40-ton units equipped with Cummins NHS 275-hp diesel engines which were later replaced with NHRS, 300-hp engines.

The above mentioned 20 and 40-ton haulage units were supplemented as the haulage distance and tonnage requirements increased. By the end of 1955 Central Ohio had nine 20-ton units and sixteen 40-ton units in operation.

Haulage Facilities of Third Mine Designed for Future Needs

Central Ohio opened its third strip mine in the vicinity of Unionville, Ohio, known as the Muskingum mine. This operation was assigned an area 15 miles long by 4 miles wide in Meigs Creek No. 9 coal field and was established for the purpose of supplying the burn requirements for the Muskingum River plant of Ohio Power.

Since the Muskingum mine coal is transported to the power plant by a 4½-mile belt conveyor which originates at the mine preparation plant



Four of these 70-ton units were used to retire a fleet of 20-ton coal haulers at one mine. Central Ohio has reduced downtime cost considerably by providing rebuilt units, such as engines, transmissions and fuel pumps

located in the extreme southeast corner of the coal field, the mine is destined to face a maximum haulage distance of 15 miles by the time this field is depleted. Furthermore, besides the long haul this mine will produce twice as much tonnage as the second mine and four times the tonnage of the first operation. With this in mind Central Ohio decided to install haulage facilities (bins, bridges, haulroads, etc.) approximately 2½ times the necessary requirements needed for the largest haulage unit available at this time. The company also designed the installed facilities so the additional load requirements could be obtained with very little additional work and expense.

The largest proven haulage unit available at this time was of the 40-ton class or the same size as the units the company had been using at its other operations. Therefore seven of these units were purchased and the only major change was the increase in engine size from 275 to 300 hp.

During the latter part of 1956 and early 1957 extended hauls and increased production made it imperative that the company purchase additional haulage units if it were to maintain its annual production. This was accomplished by purchasing seven 50-ton haulage units which carried an average payload of 55 tons. These units came equipped with 360 and 400-hp Cummins diesel engines. Four of these hoppers were found to be too light because the hoppers sagged from the load impact and they had to be reinforced to enable them to stand the terrific beating they were required to take.

Company Adds 70-Ton Units to Fleet

In the last half of 1959 Central Ohio was faced with two methods of approaching its future haulage problem—first, use small fully depreciated haulage equipment in a fleet of large haulage units or second, retire the small units and purchase units larger than the ones it had in service at its present operations. After many haulage studies it was decided to purchase four of the larger 70-ton, 450-hp units to supplement the haulage at the one mine and discard the small 20-ton units. High tensile steel was specified for the hoppers of these units and this has proven to be a contributing factor in the operating and maintenance cost savings. Then in 1960 one additional 70-ton unit was added to the fleet, making a total of 28 units.

Central Ohio has been constantly striving to improve its preventive maintenance program on coal haulers because a well planned and good operating preventive maintenance program means considerable haulage cost savings. The company has always built and maintained its haulroads with the minimum amount of grade, and at one of its operations it has tried to maintain a two percent grade with the loads in order to provide exceptional high speed haulage. It has continually called for routine servicing which includes daily inspections and lubrication, because this is necessary to obtain maximum availability from all haulage units. The last 12 units purchased were equipped with the Lincoln Automatic Lubrication system which lubricates 35 critical points. Central Ohio has reduced down time cost considerably by providing rebuilt units, such as engines, transmissions and fuel pumps. By providing these parts less time is required to change the unit and does not require the haulage unit to be out of service while the replacement part is being repaired.

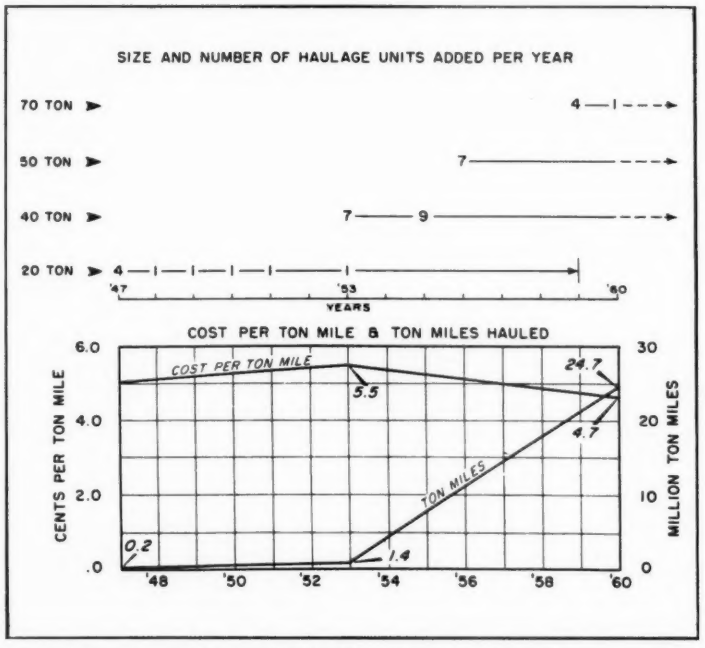
Other Costs Go Down But Tire Costs Go Up

The accompanying graph shows the ton-miles hauled, cost per ton-mile, and the amount and capacity of units as they were put into service by years.

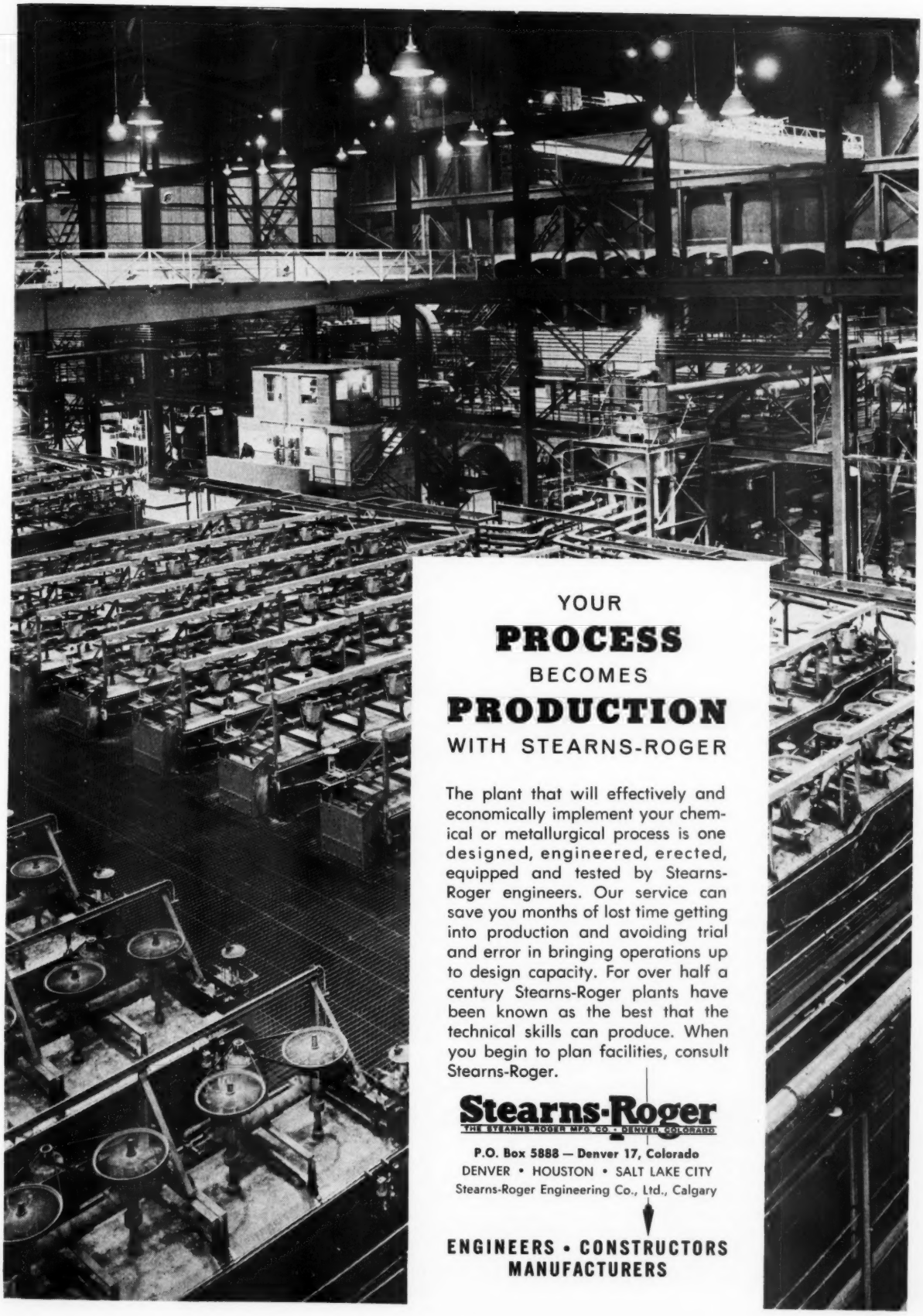
During the period 1947 to 1953 Central Ohio increased its haulage units 120 percent. The ton-miles hauled increased 430 percent and the cost per ton-mile increased ten percent. However, after 1953 the number of haulage units, having a much larger capacity, increased approximately 310 percent, the ton-miles increased 1670 percent and the cost per ton-mile decreased 14.5 percent, not forgetting the fact that labor and supplies have substantially increased during this period.

During the last mentioned period above there were many interesting but non conclusive facts and figures presented which showed that when comparing cost per ton-mile of 40-ton and larger units with 20-ton units at Central Ohio, labor and maintenance cost decreased 40 percent, operating and maintenance supplies decreased 21 percent, fuel oil decreased 25 percent while tire cost increased 40 percent.

In conclusion, larger haulage units, 40 tons or over, have proven to be the most economical method of transporting coal at Central Ohio but when looking into the future with a maximum haul of 15 miles or more, the company can see the possibility of truck trains and conveyors replacing larger haulage units as they become limited because of operational restrictions.



Graph shows by years the ton-miles hauled, cost per ton-mile, and the amount and capacity of units as they were put into service



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Operations at Weed Heights*

FACILITIES for milling copper sulfide ores by the flotation process are expected to be completed by the end of this year at the Yerington mine at Weed Heights, Nev.

This mine has been operated by the present owners, The Anaconda Co., since 1952. The current rate of mining is approximately 35,000 tpd, of which about 15,000 is ore.

In general, the ore body strikes North 63° West and most of it was overlain with gravel varying from 0 to 200 ft in thickness. Since this ore body is spotty, varying from the cut-off grade to some higher grade copper, close mining control must be maintained. Over-all average copper content is less than one percent.

Ore has been mined to a maximum depth of 300 ft in the pit area, the majority of the material obtained to date being copper oxide ore. Sulfide ores are known to be rather extensive at lower depths and it is for the treatment of this part of the deposit that a new processing facility is being constructed.

The pit is approximately 4500 ft long by 1800 ft wide, with an over-all final slope of 1:1. Average height of benches is held to 25 ft to permit selectivity in mining. Permanent haulage roads are held to an eight percent grade and all are surfaced with bituminous seal coat containing approximately 4/10 gal of asphalt per square yard. The roads are maintained with No. 12 and No. 112 motor graders.

The copper mineralization is associated with a porphyritic intrusion in granodiorite.

Prilled AN Gives Good Blasting Results

Because of the heavily-consolidated nature of the material to be mined, it must be blasted. Drilling is on a 23 ft by 25 ft pattern to a depth of 30 ft with two electrically powered Joy 58BH blast hole drills. The 7⅜ in. holes are sunk at the rate of approximately ten per shift. A water injection system is used for dust control in the drilling operation.

Each hole is loaded with approximately 200 lb of prilled ammonium nitrate mixed with one gal of diesel fuel per 80-lb sack as the reducing agent. Priming agents in use are Titan or Pro-core placed in the bottom of the hole. The use of ammonium nitrate and these insensitive primers assures that, in the event of a misfire, the danger of accidental detonation by the loading shovel will be negligible.

Drilling proceeds around the clock, holes being numbered in consecutive order in series of 10,000. Blasting is done by a day shift crew, each shot generally of three rows of holes. The total size of the shot is determined by the general pit foreman. Ordinarily, the average number of holes in a shot is 30.

The use of prilled ammonium nitrate was decided upon after much experimentation with different combinations. Results of this experimentation proved that the best blasting results and lowest costs were obtained by using fertilizer-grade prilled ammonium nitrate with diesel oil and an insensitive booster for detonating.

Blasted rock is loaded with four P&H 1500 electrically powered shovels with five-yd buckets. Hauling units consist of 30 Dart trucks with 25-ton rear dump bodies, some of which have been modified to haul 31 tons using a larger diesel unit. Two hauling units, equipped with V-8 diesel engines and light-weight steel bodies haul 35 tons each.

Pit floor cleanup around the shovels and any necessary dozing of rock are handled with Caterpillar D7 and D8 tractors.

Gravel removed from the mine is placed in dumps on the south side of the pit. Waste rock stripped from the mine is divided into two categories. Material containing less than 0.2 percent copper is placed in a dump on the northwest side of the mine. Rock containing from 0.2 to 0.4 percent copper is piled separately on the north side of the mine where in the future it can be hauled to the crusher or leached in place. All material containing over 0.4 percent copper is classed as ore and taken directly to the crushing plant.

Ore Crushed to Minus 7/16 In.

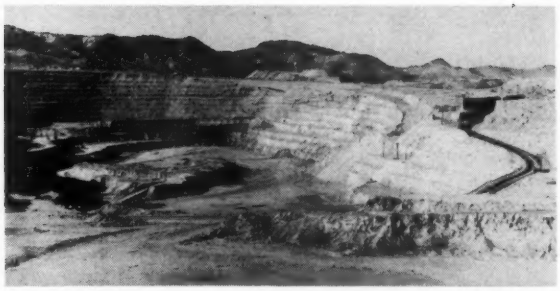
Ore is trucked to the primary crusher where it is dumped over an inclined grizzly constructed of 12 in. bars spaced at three in. openings. Oversize feeds directly into a 54-in. Traylor gyratory crusher where it is crushed to minus six in. Grizzly undersize joins the crushed ore on a 48-in. conveyor belt which takes the material to the coarse ore storage bin.

From coarse storage, a 48-in. conveyor takes the ore to the secondary crushing plant where it feeds into two double-deck screens above a seven-ft Symons standard crusher. The minus 7/16 in. material that is screened out leaves the crushing plant on a conveyor belt while the plus 7/16 in. material passes through the crusher and is taken by a system of conveyor belts to three 300-ton storage bins at the top of the secondary crusher.

From the fine ore storage bins, the ore is fed to six double-deck screens above three 7-ft Symons shorthead crushers. Again, minus 7/16 material is taken by conveyor belt from the crusher and the coarse fraction passes through the shortheads and then is returned to the fine ore storage bins at the top of the crusher. The capacity of the secondary crushing plant is about 1000 tph.

* Courtesy of Caterpillar Tractor Co.

Above the conveyor belt which takes the crushed ore from the secondary crusher there are fine water sprays at the discharge points of each of the eight screens. These sprays raise the moisture content of the ore to five or seven percent. The main purpose of this is to agglomerate the ore so that the very fine particles will adhere to the coarser ones, thus preventing separation of the material and formation of impervious layers when the ore is placed in the leaching vats.



Mining operations at the Yerington mine are presently concentrated in the left side of the pit. Main haul road is at right

Leach Tanks Lined with Asphalt Mastic

There are eight 12,000-ton leaching tanks each measuring 120 ft by 135 ft and about 19 ft deep. They are constructed of reinforced concrete and lined with an asphalt mastic. Ore is bedded in these vats by a system of conveyor belts and leached by a sulphuric acid solution. The vats are bedded in thirds to prevent a layer of ore containing a high percentage of fines, or one which might disintegrate excessively under leach, from sealing off the entire area of one leaching vat against free percolation of solutions through the ore column.

Leaching is carried out on an eight day cycle. Seven tanks weekly are bedded, leached and excavated. The normal leaching time for each tank is 120 hours. The remaining 48 hours of the seven day period are used for bedding, washing and excavation.

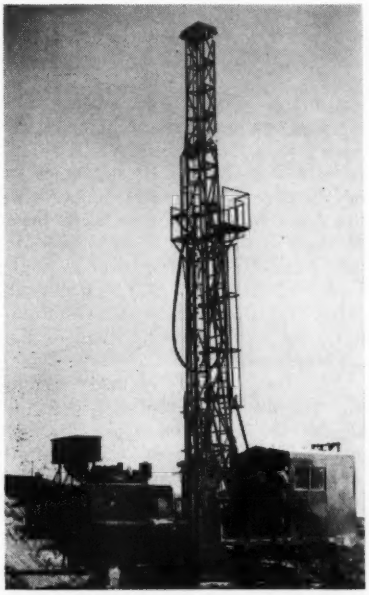
Cementation Cycle is About 4¾ Days

Copper containing solution from the leaching vats is pumped to storage tanks east of the leaching vats. The pregnant solution is taken from the tanks and circulated over light gauge scrap iron in 10-ft wide by 58-ft long concrete launders. After circulating solution through the scrap for about 4¾ days, the copper that has precipitated is removed from the launders, washed in a trommel and placed on gas-fired plates where the moisture is reduced to less than 20 percent. Copper precipitate is then hauled 12 miles to the railhead at Wabuska and shipped to Anaconda, Mont., for smelting.

Leach Plant Uses 400 Tons of Acid Daily

In order to manufacture the some 400 tons of sulphuric acid required daily for the leaching of copper ores a FluoSolids and Acid Plant was built.

Sulphur mined at the Leviathan mine in Alpine County, Calif., is brought the 58 miles to Weed Heights during the normal six months working season and stockpiled.



Blast holes of 7⅜ in. diam are drilled on a 23 by 25 ft pattern that is used for both waste and ore blasting

This sulphur ore is reclaimed from the stockpile with a D8 tractor and a No. 80 scraper and after being deposited in front of the sulphur crusher it is pushed into the surge bin above the primary crusher with another D8. In the sulphur crushing plant the material is first crushed through an 18 by 36 in. jaw crusher, then through a four-ft Symons shorthead crusher and lastly through a 5 by 10 Marcy rod mill. Ten mesh material from the rod mill is fed by conveyor belt into FluoSolids reactors, where it is burned and SO_2 gas is pulled off through coolers, Buell cyclones, a Peabody scrubber and Acid Mist precipitators. The SO_2 gas from the precipitators then enters the contact acid plant, going through primary and secondary converters, and by means of vanadium pentoxide catalysts is converted to SO_3. The SO_3 gas goes through two heat exchangers and enters the absorption tower containing 98 percent H_2SO_4 where it combines with the 2 percent of water to form acid. The acid is diluted and stored as 93 percent sulphuric acid. This plant operates continuously and is capable of making the equivalent of 450 tons of 100 percent H_2SO_4 daily.



An electrically powered shovel loads ore into a truck equipped with 35-ton capacity lightweight steel body—one of 30 trucks used for ore and waste haulage. Maximum haul is one mile

RADIOISOTOPES CONFERENCE

Present and prospective uses of radioisotopes in the mining industry explored at two-day meeting in Denver

ON April 13 and 14 the American Mining Congress and the Colorado School of Mines Research Foundation, Inc., in cooperation with the Office of Isotopes Development of the Atomic Energy Commission, sponsored a Conference on "Radioisotopes in the Mining Industry" in Denver, Colo. Over 200 mining men and manufacturers of mining equipment attended, to learn about and to discuss ways in which radioisotopes can be effectively used.

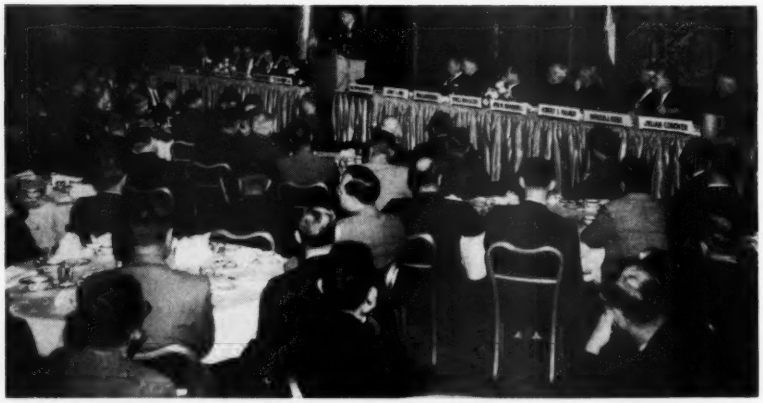
Highlight of the meeting was an address by Dr. Glenn T. Seaborg, Chairman, U. S. Atomic Energy Commission, at a special luncheon Friday, April 14. Robert M. Hardy, Jr., president, Sunshine Mining Corp., and chairman of the Western Division, American Mining Congress, presided. The Honorable Stephen L. R. McNichols, Governor of Colorado, extended an official greeting to the Conference.

In his first official address to the mining industry since becoming AEC Chairman, Dr. Seaborg said that progress in the field of radioisotopes is developing so rapidly that the mining industry should keep close check on these developments during the next few years to see how they effect the evolution of mining technology. By the end of February 1961, he said, there had been 146,000 shipments of radioactive materials to licensees for use in various industrial applications. He then went on to discuss briefly the use of radioisotopes in industrial areas other than mining saying that the Conference speakers sessions would thoroughly develop their potential use in mining.

The Conference was opened by Julian Conover, AMC executive vice president, who said that the meeting was being held to acquaint the mining and equipment manufacturing industry with the many ways in which radioisotopes can be of assistance in reducing costs or finding answers to problems that heretofore have been difficult or impossible to solve. He then turned the meeting over to E. H. Crabtree, Director of Colorado School of Mines Research Foundation, Inc., who was Chairman of the opening session.

The first speaker on the program was Dr. Paul C. Aebersold, director of the Office of Isotopes Development's Atomic Energy Commission, Washington, D. C. Dr. Aebersold reported that over 1700 major industrial organizations are using radioisotopes to carry out their manufacturing and research activities more easily, cheaply and quickly, or to do jobs that heretofore were either impractical or impossible. He described a radioisotope as an unstable atom, one that cannot exist indefinitely in nature. In breaking down, this unstable structure emits radiation; perhaps heavy, intensely ionizing, but short range alpha particles; perhaps the light beta particle that can penetrate or be reflected from thin materials; and in most cases the very penetrating gamma rays. The great variety of radioisotope uses can be divided into three broad classes—1, tracer atoms, where their application is based on the detectability of very small amounts of radioisotopes; 2, measurement by radiation, that is through radiography and the use of a great variety of nuclear gauges in measuring thickness, or density and levels in process control; and 3, high intensity radiation in which the properties of materials can be altered, chemical reactions can be initiated, or critical supplies sterilized.

Radioisotope techniques have important possibilities in mineral exploration, mining operations, and the processing and use of ores and minerals, Harold J. Rose, consultant, Nuclear Science and Engineering



Headlight of the conference was an address by Dr. Glenn T. Seaborg, Chairman, Atomic Energy Commission, at a luncheon on Friday, April 14

Corp., Pittsburgh, Pa., reported in the second paper of the morning. He presented a check list of existing and potential applications of radioisotopes in the mining industries: Included were references to mineral exploration; mine planning; mining operations; preparation processes; storage, weighing, handling and transportation; equipment maintenance; sampling, analysis and testing; and controlling air and stream pollution. In the field of exploration, he suggested the use of existing water, oil and gas wells, as a potential source of information gained from logging with radioisotope devices.

Radioisotopes in Geology, Chemistry and Geochemistry

Chairman for the Thursday afternoon session, which was devoted to radioisotopes in geology, geochemistry, chemistry and mineral processing research, was Paul J. Blaetus, chief, Isotope Technology Branch, Office of Isotopes Developments, Atomic Energy Commission, Washington, D. C. Blaetus took over for E. I. Renouard, vice president of The Anaconda Co., who was unable to be present.

The speaker was W. M. Thaddenham, head of the Analytical Services and Special Studies Department, Western Mining Divisions Research Center, Kennecott Copper Corp., Salt Lake City, Utah, who presented a paper prepared in collaboration with Henry W. Franz, project engineer at Kennecott. Careful consideration of the potential uses of radioisotopes in industrial applications, the speaker said, indicates a number of areas with great potential from the point of view of direct savings in process control or of obtaining information leading to improved methods of operation. He said that Kennecott had used radioisotopes in both research and operations in at least four widely varying areas. These include the age-dating of igneous rocks, a study of milling operations to obtain data on the grinding and flotation behavior of relatively course free-gold present in some of the company's ores; the use of high energy sources for control of levels and densities in a general milling program, and a study of the fundamental nature of electrolitic deposits in an attempt to diagnose electrolitic refining problems.

Samuel S. Goldich, chief of isotope geology at the U.S. Geological Survey, Washington, D. C., in his talk, "Radioactivity Dating of Major Earth Structures," described some of the radioisotope techniques used in making accurate age determinations of rocks in historical geology. By comparing the results of isotope age-dating of younger rocks with other methods he showed that consistently accurate results can be attained. Methods developed in the past ten years have been successfully applied in determining the ages of rock formed in Pre-Cambrian times, which he pointed out, comprise some 85 percent of all geologic history. Goldich went on to discuss in detail his age studies in the Canadian Shield where the U. S. Geological Survey has been able to correlate the relative ages of many structures in the Lake Superior district and other major mineral producing areas such as Sudbury, the Labrador trough and northern Manitoba.



Speakers at the opening session included: Julian Conover, American Mining Congress; E. H. Crabtree, Colorado School of Mines Research Foundation; Paul C. Aebersold, Atomic Energy Commission; and Harold J. Rose, Nuclear Science and Engineering Corp.

Borehole applications of radioisotopes was the subject of a discussion by A. H. Roebuck, assistant manager, and R. G. Loper, supervisor of logging technology, Westco Research, The Western Co., Fort Worth, Tex. Loper, who presented the talk, reported that radioisotopes may be utilized for the study of boreholes and underground reservoirs in a myriad of methods. Studies may be used to determine the subterranean movement of water, gas or liquid hydrocarbons. The fundamentals of the placement of various solids, liquids and vapors has also been successfully traced with radioisotopes. A number of examples were used to illustrate each application.

J. Kent Perry, geological engineer, The Colorado School of Mines Research Foundation, Inc., Golden Colo., in a talk on "Neutron Activation Analysis Applied to Geochemical Studies" said that geochemical techniques will become increasingly important in future exploration for ore deposits. He described progress in the application of neutron activation analysis to determine the distribution of trace elements in wallrocks of ore deposits. Samples are irradiated in a nuclear reactor which produces radioisotopes of the elements originally present. Trace elements are identified and quantitatively determined by analyzing the induced radiation. Potential sensitivity of the method is one part per million to one part per billion for about 70 elements. He said that the Colorado School of Mines Research Foundation is attempting to use gamma-ray spectrometry directly on activated samples without chemical separations to reduce per sample cost. It is hoped that determination errors can be reduced to 10 percent or less. Success of this method will permit using elements present in quantities less than one part per million for geochemical exploration. Some of these elements may yield more diagnostic anomalies than the trace elements being utilized at present.

"Radio Physics in the Identification of Beryllium" was the title of a paper prepared by H. L. Gibbs, supervising metallurgist, Region III, U. S. Bureau of Mines, Salt Lake City, and B. H. Clemmons, research director, Salt Lake City Metallurgical Research Center, U. S. Bureau of Mines, Salt Lake. The authors dealt primarily with the use of laboratory-type beryllium detection and eval-

uation devices, and outlined the Bureau's over-all background in radioisotope use. Studies have encompassed radioactive "tagging" by the addition of known quantities of radioactive materials to pulps or solutions containing unknown quantities of the same element, and subsequent tracing to determine the deportment of this element in various leaching, solvent extraction, ion exchange, and electrolysis operations. Tracers have been used effectively in the recovery of volatile elements such as selenium and tellurium by fuming methods. Isotopes have also proven invaluable in the Bureau's development of dependable procedures for evaluating research test products. This has been particularly true in its work with uncommon elements such as rhenium, rubidium, cesium, selenium, tellurium, and scandium, where standard analytical methods are scarce or nonexistent. The paper then went on to describe a beryllium detector which was built at the Salt Lake City Metallurgical Research Center to analyze ores, prospectors samples, leach residues, concentrates, middlings, and tailings containing beryllium. Beryllium content of many samples evaluated by the unit subsequently have been verified by chemical analysis.

Applications in Mineral Processing

Friday morning was devoted to a discussion of radioisotope applications in mineral processing. Chairman Robert Henderson, vice president of western operations, Climax Molybdenum Co., Golden, Colo., in introducing the session, stressed the great need in industry for the use of imaginative concepts such as radioisotopes in improving its products and processes to meet the ever-growing competition.

The first address was given by Philip E. Ohmart, president. The Ohmart Corp., Cincinnati, Ohio. He discussed "Application of Nuclear Density Gauges in the Mining Industry," explaining that these instruments have real appeal to men in industry because they can be installed easily and have no moving parts. But the true measure of their value, he observed, is whether they can "make a buck" for the operator. He went on to give examples of installations where the monetary profit to the operator was substantial. These included: a density gauge installation by Ideal Cement Co. which has enabled the company to increase milling efficiency and plant output; an application which led to the elimination of excessively hot areas in a kiln—it saved enough in maintenance of the refractory liner to pay for itself in four months; a gauge used to maintain constant gravity in heavy media fluids; the installation in taconite concentration described in more detail by Mr. Hoveland, and an installation on a dredge on the Orinoco River where positioning of the suction head is controlled with a density gauge. Ohmart pointed out that equipment now on the market is rugged enough to withstand almost any kind of hard treatment—even fire up to 2500°—that it is safe, and that it is available in many sizes adaptable to widely varying conditions. A new application, which he said holds real promise, is the use of density gauges in continuous weighing of dry solids in transit.

The subject of a discussion by Henry P. Whaley, superintendent of ore dressing, and Mark L. Hoveland, metallurgist, Erie Mining Co., Hoyt Lakes, Minn., was "Radioisotope Applications in Iron Ore Processing." Presented by Hoveland, it described a radioisotope control system used to automatically control the operation of each 27 identical mill lines performing the grinding and concentrating phases at the taconite plant of Erie Mining Co. in northern Minnesota. At the present time, Erie is grinding taconite ore to recover a concentrate assaying 89 to 90 percent minus 325 mesh. It is extremely important that the size consist of the concentrate be held constant because of its effect on the subsequent filtering, balling and pelletizing phases of the agglomeration process. After studying the five variables which affected plant performance, Erie concluded that emphasis should be placed on holding the cyclone feed density constant, and a radioactive gamma gauge was installed on the cylone feed pipes of one of the grinding lines in late 1958. Since that time, all 27 grinding lines have been converted to this system. Information from the gamma ray density gauges is fed to an automatic control circuit which controls the tonnage fed to the grinding line. Experience has shown that this system can maintain an accuracy to within plus or minus 1½ percent of the desired.

The automatic grinding system at Erie has allowed closer control of mill concentrate, reduced operating manpower requirements, permitted a reduction in the sampling required, and allowed the maintenance of a maximum tonnage through the plant at all times. The system is capable of sensing and correcting for any change and/or characteristics that may occur. The gamma ray density gauge can be considered a key to the successful development of this automatic system. It has proven to be an accurate instrument for measuring, on a continuous basis, the cyclone feed density which is the pulse of a closed circuit grinding system.

O. Kenton Neville, vice president of Nuclear-Chicago Corp., Franklin Park, Ill., in his talk, "Principles and Operation of Density/Moisture Gauges," said that the nuclear instrument business fits into mining in a natural way. Mentioning the extremely wide divergence of available devices and applications, he pointed out that nuclear gauges are built to do a specific job, and that the average industrial user needn't be particularly concerned about its radioactive features. Research scientists, on the other hand, may often have occasion to delve into the radiation source of such instruments and should be thoroughly familiar with their hazards and radioactivity characteristics. Neville discussed several different types of gauges explaining what they can, and cannot do. Slurry gauges, for instance, do a fine job of controlling the density of fluids in pipelines, but are not able to measure the moisture in bulk solids such as raw feed to a ball mill, or the filtrate at the end of the milling operation. For such applications a bulk moisture gauge, which operates on the principle of reflection of radiation rather than transmission of it, is used. Often two separate gauges coupled with a small computer are necessary—one measuring moisture, the other measuring density of the solid material, with the computer combining this information to come up with a reading in parts of water per weight-unit of solids. In conclusion, Neville stressed the ease with which jobs can be performed by these instruments and the dollar savings which they can bring to industry if used in the right places.

"Radioisotopes for Coarse Ore Concentration" was the subject of a discussion by A. M. Gaudin, Richards Professor of Mineral Engineering, and Maurice Fuerstenau, Research Associate, Department of Metallurgy, Massachusetts Institute of Technology, Cambridge, Mass. The paper covered experiments in the development of an ore separating process based on the induction of radioactivity into mineral bearing rock and waste. Progress to date shows that the mineral content of lumps containing various percentages of copper

in the form of chalcocite can be determined in this manner. The amount of radioactivity remaining in each piece is proportional to its copper content. The next phase in the investigation will include the designing and setting up of a picker that will utilize the difference in radioactivity to make the separation.

A "Summary of Applications in Process Control" was presented by James Gary, head of the Petroleum Refining Department, Colorado School of Mines Research Foundation, Inc. He reviewed some of the unique properties of radioisotopes which make them so useful in mineral dressing. Among these is the phenomenon that they emit radiation that can be identified as coming from a particular isotope. This radiation, he explained, is a function of the mass through which it passes, or off which it is reflected, and can be measured and evaluated to give particular results. Advantages of devices built to operate on the radioisotope principle are: that they can be put in place without interfering with plant operation; that they are not affected by the material they are measuring; and that they require a minimum of maintenance. Gary then discussed the three types of radiation, gamma rays, beta rays and neutrons. Each has its own set of properties, making it important to select the best type of radiation for a particular job. Applications discussed by Gary were: 1) measurement of solids in a blast furnace, 2) measurement of solids in a bin or hopper, 3) determination of angles of repose—as in a ball mill, 4) measurements of density and thickness, 5) determination of flow rates of either dry or wet material, 6) controlling uniformity of bed density in fluidized bed processing, 7) continuous measurement of the quality of live steam, 8) separation of waste material from ore or coal—when particles are large enough to be isolated and removed, and 9) measurement of hydrogen content.

Applications in Quality Control, Maintenance and Testing

The Conference roundup Friday afternoon covered applications in quality control, maintenance and testing. Albert E. Seep, President, Mine and Smelter Supply Co., Denver, presided. The first talk of the afternoon, on "Radiography in Maintenance," was given by R. O. Bardwell, nuclear engineer, Denver & Rio Grande Western Railroad Co. Bardwell described radiography as the art of examining



Many thought-provoking ideas were generated by the various conference speakers, who described how radioisotopes are being used by miner, geologist, millman and researcher to increase efficiency or solve problems heretofore impossible to answer

the interior of objects using penetrating radiation, and said that its use has grown in industry along with the whole field of nondestructive testing. Among other uses, he said, radiography of riveted joints in pressure vessels has been successful—radial cracks under rivet heads can be detected by no other method. It has been used to measure the degree of corrosion in refinery vessels and insulated pipes without stopping the fluid flow and without removing the insulation. Radiography has also been used widely by the railroad industry to inspect welded rail joints. Bardwell went on to say that the mining industry can make great application of this new tool in its maintenance program. The wide variety of apparatus, the growing number of trained people in the field, and the availability of these services on a contract basis, all tend to make radiography a more valuable tool in maintenance work, he concluded.

"Radiography in the Fabrication and Manufacture of Critical Equipment" was the subject of a paper by Walter B. Hester, director of engineering, and Herman Geller, senior mechanical engineer, the Stearns-Roger Manufacturing Co., Denver. Geller, who presented the paper, observed that the mining industry has been steadily increasing its use of mechanization to reduce production costs. Economic forces are increasing the use of low grade ores, which require more and larger machines to achieve profitable operation. Increased dependence on machinery demands higher standards of manufacturing quality, planned maintenance and inspection to eliminate costly down-time. Radiography provides the only reliable means for detailed examination of the internal structure of machine elements. Artificial radioisotopes provide a source of gamma radiation which is self-contained and does not require a power or cooling supply. They are available now at low cost, and the operational savings are limited only by the industry's ingenuity in applying them, Geller said.

T. R. Young, assistant manager, Mining Division, Colorado School of Mines Research Foundation, Inc., Golden, Colo., discussed "Measuring Wear in Pipelines." In experiments at the Research Foundation, pipe wear is measured by inserting an irradiated 60° segment of pipe in the pipeline, which is then tested under operating conditions. The amount of radioactivity in the slurry is measured. Since this radioactivity is directly proportional to the amount of metal worn away, it is possible to determine the rate of wear under various conditions. For instance, by rotating the insert, it is possible to determine the rate of wear at different sections of the pipeline. At the Colorado School of Mines Research Foundation, it has been shown that pipeline wear ranges from approximately nothing for a minus 100-mesh limestone slurry to almost 0.30 in. per million dry tons of solids for fairly coarse iron ore tailings containing a large amount of quartz.

Paul J. Blaetus, chief, Isotope Technology Branch, Office of Isotope Development, Atomic Energy Commission, Washington, D.C., concluded the Conference with a talk entitled "Training for Industrial Applications of Radioisotopes." He said that many of the present radioisotope techniques could be taken advantage of without extensive training, or without need for a license by a mine operator. The supplier of nuclear equipment places the instrument and recalibrates it periodically to assure its continuing safe operation. If the source of radioactivity is large, however, trained personnel are required. He then went on to outline how this training could be easily acquired, and discussed the assistance that is available from the Atomic Energy Commission in instituting a broad or limited program using radioisotopes.



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MINING CONGRESS JOURNAL

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LARGE COMPANY EXPLORATION

By GLENN C. WATERMAN
Chief Geologist
The Anaconda Co. (Canada) Ltd.

"Successful exploration results from a combination of careful geological investigations, efficient field programs which test geological ideas, continued appraisal of programs in the light of new geologic facts, constant assessment of the odds in terms of the value of the target sought, and lastly, courage and good luck"

A large mining company usually is in the exploration business because its continued existence depends on finding new ore to replace wasting assets. Because of its size, stability, and earnings, it is able to conduct exploration in a somewhat different manner than a small mining company. The writer will give a synoptic review of what he considers to be an average approach of a large metal mining company towards mineral exploration.

For our purpose let us call a company "large" if it has several productive mining properties, produces more than one metal, has sufficient capital to undertake costly exploration and development programs without requiring immediate returns, has integrated geological, mining, marketing, legal and accounting divisions, and is thinking in terms of future as well as present resources and demands of metals.

Because a large company can think in terms of future as well as immediate needs, it is able to afford research teams whose continuing jobs are to improve the company's future competitive position in mining, metallurgy, marketing, etc. Fundamental research in geology, geophysics, chemistry and physics is also important although its value cannot be predicted, and, generally, lies in the future. Research results are often of great importance in aiding exploration.

In considering exploration, some large companies restrict their efforts to metals with which they are very familiar; others think in terms of any metal that might be profitable. Many companies expand into new fields for purposes of having a broader base for maintenance of financial stability during cyclic economic changes as well as to hedge on variations in metal demand as new techniques, products and substitutes become important.

What Factors Are Involved?

A large company generally plans its broad, over-all exploration program after a careful consideration of economics, politics, business, and geology. Results of these investigations help resolve the questions:

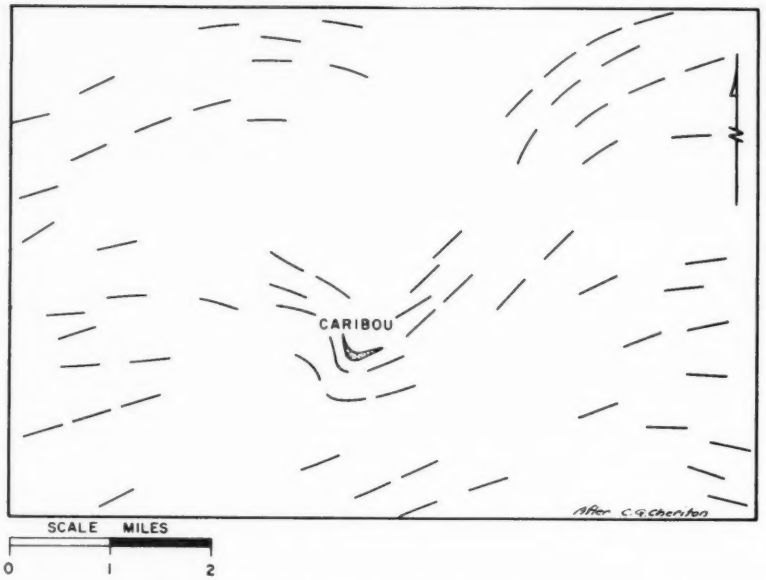
1. **What shall we look for?**
2. **Where shall we look?**
3. **How do we look?**

The question "What shall we look for?" can be answered by a general analysis of present and probable future economic and business problems involved in metal mining, fabricating, and marketing. Let us consider a few economic problems that affect the common non-ferrous metals, copper, lead, zinc, aluminum, nickel, etc.

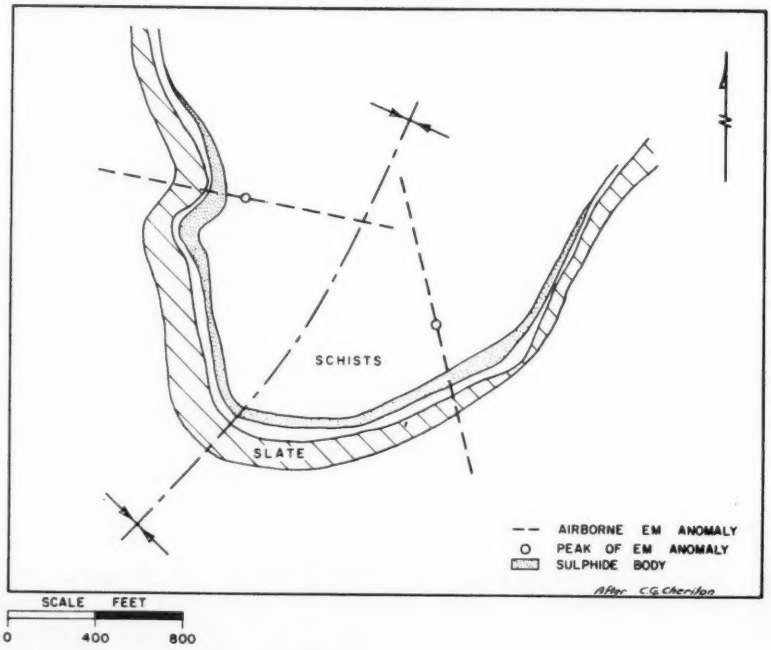
Estimates must be made of the probable future supply and demand for each metal as populations increase as well as the expected increases or decreases of metal demand per unit of population. Such estimates must consider possible important changes in price structure that may be brought about by over-supply or under-supply or the availability of

substitutes. Short term and long term data can suggest which metals are of immediate and/or future interest.

A second important consideration is the position of the company's ore reserve in terms of the long range look at various metals. Management must analyse company reserves in terms of production costs, grade, and total metal content, project the depletion of reserves due to mining ahead for five, ten, twenty years, estimate the economic worth of remaining reserves, and determine how much new ore, if any, must be found to maintain a desired company position. Company reserves must be subdivided into distribution in various countries, and estimated future political and business considerations called on to evaluate the worth of each block of reserves.



(Above) Photo-linears of the Caribou area of New Brunswick where Anaconda geologists discovered a massive sulphide deposit in 1955. Recognition of a focus of favorable rocks and structures, followed by applied geophysics and soil sampling outlined the ore area shown below



Let us consider the rarer or more exotic metals. Three divisions can be made:

1. Metals that have special qualities which indicate continuing markets under any reasonable guess as to the future. Often these markets would expand if important new reserves could be located. Beryllium is a good example of this class of metal.
2. Metals with unique qualities but practically no reserves. Rhenium is an excellent example. It is not unlikely that with a larger assured source of metal, demand would rapidly expand. Intensive research and increased uses often follow discovery of a new supply of metal.
3. Metals with interesting qualities, fairly important reserves, but not sufficient demand to warrant important exploitation. Columbium is a metal of this class and it is interesting that it is receiving more research attention since metal supply is no longer a serious problem.

Estimates of future value of the rarer metals are fraught with danger because research breakthroughs, which can make any such metal much more or much less valuable, cannot be predicted. Germanium can be cited as a metal that rose from obscurity to prominence through research, and which has lost considerable value as a result of additional research which found a substitute.

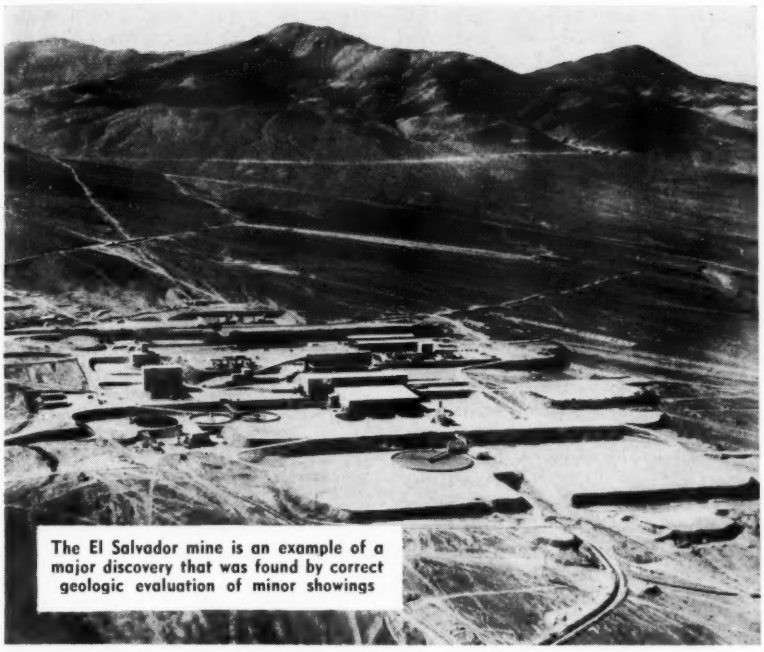
Program Depends on Estimated Future Markets

A large company that can afford modest losses based on acceptable gambles of rare metal futures often acquires or develops reserves of possible future value and awaits research results. A small company rarely can afford this luxury. However, nonproductive capital investments are usually poor business. The same capital might be more usefully used in developing reserves of metals which have a more immediate profit potential.

Summarizing, large company management usually takes a long, hard look at the present and estimated future value and demand for most metals, its own position within such a future, and then decides what metal resources it should try to develop in a continuing program of exploration. Constant re-appraisal of the future in the light of the changeable present, and the productivity of exploration dollars makes for controlled flexibility.

The above discussion is a partial answer to "What shall we look for?" This is often the general starting point for long range, world-wide exploration.

Our second pertinent question is "Where shall we look?" This question will be discussed in terms of ex-



The El Salvador mine is an example of a major discovery that was found by correct geologic evaluation of minor showings

ploration which is designed to find certain kinds of ores in areas where favorable political and business situations exist.

Successful exploration results from a combination of careful geological investigations, efficient field programs which test geological ideas, continued appraisal of programs in the light of new geologic facts, constant assessment of the odds in terms of the value of the target sought, and lastly, courage and good luck.

Program May Hinge on Ore Control Concepts

In exploration, probably the most important aspect of geology is ore genesis. As Reno Sales said in his 1954 Jackling lecture, "Every mine manager, mine geologist, and prospector in the field who appraises the future of mining properties does so on the basis of a theory of ore deposition whether he recognizes this fact or not." Paraphrasing this, any geologist who recommends exploration expenditures in areas of particular fancy does so because of his experience and understanding of how ores form and what may control them. At each stage of an exploration venture, continued work or abandonment may depend on the geologists ideas of ore controls.

Theories of ore genesis and arguments pro and con fill many volumes; supporting facts are often diluted by enthusiasm in attempts to prove ideas. Significant progress in understanding ore genesis results when a careful recording and analysis of field facts is supplemented by laboratory investigations, and is augmented by theoretical chemical and physical analysis to help explain the facts and permit reasonable extrapolation. Special theories which are largely based on theoretical considerations, but run counter to significant field facts, should not occupy an important segment of an exploration man's basic philosophy of ore genesis.

Ore bodies are freaks of nature and they generally form when a very special series of important events occur in proper sequence at a specific, favorable locality. Ore search ranges over the world in rocks from oldest pre-Cambrian to Tertiary, and involves sediments, volcanics, intrusives, or metamorphic products. The rocks represent near surface to deeply buried environments that may have suffered multiple orogenics or be but little disturbed. It is a fact that the geological setting of ore is extremely variable. We know that there are a number of different types of ore of the several base metals, each differing from the others because there were differences in the original physical and chemical environment.

The above suggests that rigid concepts of ore genesis which influence ore search in areas of different geologic setting often ignore the variable complexities of geology as they affect ore deposition.

Geology Is No Place for "Frozen" Ideas

The aspects of ore genesis which are of practical importance in broad exploration are an appreciation of what may be significant controls of ores of various metals under a wide range of geologic environments, and the ability of an observer to recognize significant features of geology which, in each case, suggests ore possibilities.

Genetic concepts are a basis for investigating target areas that may contain potential ore. Preliminary reconnaissance usually supplies facts that support theory or suggest pertinent modifications; subsequent work can be better directed. Additional field work will provide facts which may help shape the odds against further work, or suggest that the potential worth of the target sought warrants further investigation. It is as important to know when additional work is justified as it is to know when to quit. Nowhere in this exploration process is there any place for "frozen" ideas, correctly or erroneously arrived at, and doggedly pursued. In geology, exceptions to rules create new rules to which there will be subsequent exceptions.

Again the question, "Where shall we look?" There are three limiting factors:

1. **Geological appraisal.**
2. **Political appraisal.**
3. **Business appraisal.**

Although exploration expenditures may be allocated only to areas or countries in which politics and business appear to be favorable, geological appraisal should not be so restricted. Political climates change; business situations may improve. It is well to have exploration ideas "on tap" as areas become more attractive.

Different Approaches to Exploration

Let us discuss the development of target areas from a geological standpoint.

An old mining phrase is: "Mines are where you find them." A more sophisticated revision tells us "If you are looking for elephants, go to elephant country"—or another, "Where there is smoke there is fire." These three "ideas" outline three different approaches to mining exploration.

By the first, a large company can attempt to locate within the partially explored regions of the world a geological situation that simulates the environment of a known mining district. Significant features often suggest a potential target that can be

worth first stage investigation. Successive steps depend on the degree of encouragement, and suggest the odds and costs involved in subsequent work. This direction of exploration seeks to find new districts and it follows that the background facts may be meager, the odds pretty long, but the prize worth the risk.

Inco's new Manitoba nickel properties are a prime example of a successful exploration search for a new district. It may be that attention was directed to this area because a known belt of basic intrusives, with minor nickel content, was distributed along an important regional discontinuity in the earth's crust. The St. Joe Lead discovery of important lead-zinc orebodies at Virburnum is a case history of a successful ore search based on careful geological studies of known ore and the extrapolation of significant data into new areas. Cominco's Pine Point lead-zinc deposit is another example.

A second possible type of worldwide exploration is to find a new "elephant" in known "elephant" country. Attention is drawn to the major mining districts of the world. In order to venture in this direction, we must accept the premise that to be successful, and discover a new "elephant," we must know as much about a district as those who mine there. We must generally take the background of geological fact and come up with new meritorious ideas. To duplicate previous exploration ideas usually either kills the same target deader than dead, or finds the orebody somebody else already found.

A number of important mines have recently been found by adopting this type of exploration. Kennecott's important lead-zinc discovery in Tintic, where geochemistry, alteration, and significant structure combined to indicate a target area is one example. Another is Anaconda's Caribou massive sulphide deposit in New Brunswick, where recognition of a focus of favorable rocks and structure, followed by applied airborne and ground geophysics and soil sampling, outlined the ore area.

The third exploration direction is to take an area containing fairly widespread, weak but significant mineralization, in a generally attractive geologic setting, and attempt to locate the important deposit that may be hidden. This type of exploration is both similar to, and different from, those previously described. Different ideas need to be developed. Some facts are available for study, but there may not be important local mineral deposits to use as yardsticks. However, geologic knowledge of other districts may often provide important clues to direct exploration. A major discovery may be found by correct geologic evaluation of minor showings. Important mines that have been found by investigations of this kind are Asarco's copper deposit near Tucson, and Anaconda's El Salvador mine.

Significance of Metallogenic Provinces in Exploration

The concept of metallogenic provinces is significant in planning worldwide ore search. Deposits of certain metals often occur in provinces and although the explanation may be nebulous, the occurrences are not illusory. An appreciation of metallogenic provinces may direct attention to regions which might contain unfound districts, or important "elephants," or where "smoke" may be significant. If the geological controls of provinces can be visualized, it might be possible to recognize potential new provinces.

Exploration targets that can be recommended to a large company because of significant geology must be analyzed from political and business points of view. Foreign exploration is usually restricted to countries which, by virtue of an encouraging political climate and favorable business arrangements, offer reasonable odds that exploration success can be followed by a profitable return commensurate with the capital risked in the development of an enterprise.

Political Conditions Must be Considered

Because of political situations, a significant portion of the world cannot, at present, be considered attractive for risk capital. However, politics change and conditions often improve, or vice versa. It is important that exploration thinking is not confined solely to those portions of the world which are currently attractive.

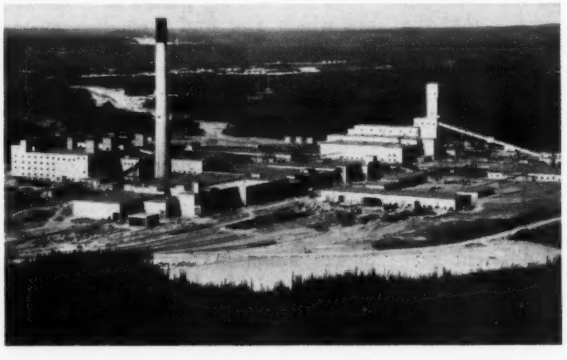
Many countries, aside from the long established democracies, have political problems that conspire against the development of a successful foreign business enterprise. Among features that must be carefully analyzed are:

1. **Stability of the current government.**
2. **Relative strength of the several political factions.**
3. **Past history and current position of American investments and ownership.**
4. **Present and possible future racial problems.**
5. **Strength of the judicial system.**

The business climate of a proposed exploration area must also be scrutinized. The following items can be very important:

1. **Present and estimated future taxation policies on profits and/or production.**
2. **Import and export restrictions on supplies and profits.**
3. **Government exchange regulations.**
4. **Validity of contractural arrangements.**
5. **Availability of labor, supplies, power, etc.**
6. **Transportation problems.**
7. **Estimated costs.**
8. **Title acquisition problems.**

In answer to the general question, "Where do we look?" it must be obvious that good exploration targets are those that can stand up to careful geological, political, and business scrutiny.



It is as important to know when additional exploration is justified as it is to know when to quit—there is no place in exploration for "frozen" ideas correctly or erroneously arrived at and doggedly pursued. Inco's Manitoba nickel properties are an example of a successful search for a new district

Careful Evaluation Needed at Each Step of Program

The remaining question is "How do we look?" In the past many mines were found by patiently awaiting the arrival of a prospector with ore specimens from a new discovery, or his further development of old, well known showings. Because the old prospector is a vanishing breed and because most of the fairly accessible outcropping ore bodies have been found, most new discoveries will be

(Continued on page 71)

Human engineering in safety

Knowledge of human behavior can pay off in increased safety

By C. G. EVANS
Personnel Manager
The North American Coal Corp.

THERE are various terms used in describing human engineering, such as, applied experimental psychology, engineering psychology, biomechanics, psychological problems in equipment design, the human factor in equipment design, and various other titles. Any of these terms could be used as basic subject matter for this article.

Man-Machine Relationship

Psychology itself is concerned with the behavior of human beings. *We* are concerned with behavior as it relates itself to industrial procedures and, more especially, with one's behavior in "man-machine" relations. Psychology also is a basis for attempting to find out more about the abilities and capacities of man because we want to know how well and how safely he can work with various machines.

The applied experimental psychologist is concerned with the machine and conditions under which men must work. Is the machine designed for safe operation in a given situation or is it simply designed for production disregarding the human factor? Has everything been done to simplify the operation? Is it designed to give the operator maximum safety in its practical operations? These problems concern not only the machine design but also incorporate problems of the human beings who will use the machine.

Ross A. McFarland, associate professor of industrial hygiene, Harvard School of Public Health, has this to say about safe working conditions: "The *Human Engineering* approach to the solution of the accident problem is to build machines and working areas around the operator rather than place him in a setting without regard to his requirements and capacities. Unless this is done, it is hardly fair to attribute so many accidents to human failure as is usually the case. All possible faults in equipment and in working area, as well as the capacities of the operator, should be subjected to advance analysis. If defects are present, it is only a matter of time before some operator 'fails' and has an accident."

The field of human engineering, therefore, is concerned about the relationship of men and machines. We are then concerned about the ease of operation, safety of the men, work procedures, mining methods, even the arrangement of the machines as a group, and roof control for the different types of machines. Finally, the industrial psychologist is also concerned about the type of people necessary or available to best operate these machines to bring about the safest and most efficient production.

The Safety Committee of the American Mining Congress has acquainted industry from time to time with its suggestions to manufacturers of mining machines concerning various safety measures that should be incorporated in the design of equipment. These suggestions have been brought about by the fact that numerous accidents have occurred in mines that force them to do something to prevent a recurrence of accidents while operating the equipment. This is rightfully called human engineering.

Work Simplification Program Pays off

Time and motion studies are also a definite part of human engineering. Time study is the process of finding the most efficient working rate of a man-machine relationship. In some cases the base rate of pay is also established upon this type of study. Motion study is concerned primarily with activity of the operator rather than the machine. This works in conjunction with work simplification.

From a standpoint of safety in human engineering, the writer strongly recommends time-motion study to establish methods and work habits as outlined under a proper control of work simplification. One of North American Coal Corporation's lowest cost mines, from a standpoint of workmen's compensation costs, is a mine where work simplification is followed minutely. Even the methods used by the foreman to carry on his responsibilities are outlined in detail. In too many cases men have applied old methods to new jobs by trial and error. In some cases no formal training program at all is used even when new machinery is introduced. There are a few companies who have people responsible for training operators but for the most part the face foremen instruct the men and the company simply waits for production to reach a calculated norm after each man has learned his particular job.

It is the opinion of the writer that our attitude toward human engineering as it relates to safe work habits is best expressed in our acceptance of the use of goggles in and around mines. Getting men and foremen to wear goggles has been one of the writer's most difficult assignments as an administrator. In the chemical industry where acids are handled, all workmen, supervisors, and even visitors must wear eye protection around tank cars, pipes, and tanks, when the only hazard may be a small leak. Because of proper inspection and maintenance programs, many workmen around a chemical plant have worked a lifetime without being exposed to airborne acid due to a leak or ruptured pipe. If the chemical industry can enforce such a regulation, then the mining industry should be able to prevail upon the men the importance of wearing goggles while performing a striking or digging operation. In fact, in at least one state of the four in which North American Coal oper-

ates, it has very little trouble with goggles. Principally, because of the attitude of the mine inspectors, management is *forced* to lead the way in this program. This example is just one of many that really express our inward opinion of safe work habits. In most cases, we actually only do lip service to a safety program.

Better Design of Machines Needed

Another example is in controls for face equipment. One company has already designed a set of controls for remote control of a continuous miner in order to move the machine if the top becomes bad. Why, then, does an operator in, for instance, low coal have to sit or stand cramped in an unnatural position to operate the machine? He could just as well have remote controls where he could see what the cutting heads are doing instead of being located at the back of the machine where he has to have a helper tell him which way to go. Convention says the controls must be on the machine, so that is where they are placed. The welfare of the operator is not considered. Again, very rarely are two levers or buttons designed alike on machines. Why couldn't all levers having the same function be standardized as to their shape and color so as to simplify training programs that have to do with the training of operators for different machines. All automobiles are operated basically the same. Why, then, is it necessary for various makes of continuous miners to have different control levers located in different positions? This is what the writer means by human engineering. If we are to attain good safety records, then more thought should be given to simplify the operation of machines; also to eliminate as far as possible even the effort involved in operating the controls. In most cases remote controls would increase the efficiency of the operations. This is especially important since machines are getting bigger and bigger, necessitating more and more unsupported top area and blind spots that the operator cannot see.

Recently, North American Coal used a consultant to study the top conditions in one of its mines and to make suggestions as to better mining methods for roof control purposes. After he completed his survey, a set of standards was established for size of pillars, also, for width and depth of working places. Now the mine has standards for several types of mining methods that permit more room for the operator and more safety for the exposed men. Even though the company has increased the size of pillars, this action has resulted in a higher percentage of recovery of coal and vastly increased the safety of the men from roof falls. In fact, the mine has not had a squeeze or creep where his recommendations have been followed. If the company had not experienced falls resulting in thousands of dollars of damage, it probably would still be using the old trial and error methods of years ago. The relationship between men and machines points out the need for research in all areas and constant improvement in our men, methods and machines.

Summary of Man-Machine Relationship

Industry needs:

a. **A better work simplification program.**
b. **Improved machine design to assure better maneuverability.**
c. **Improved machine design to assure better working conditions for the operator.**
d. **More attention to mining plans.**
e. **Exhaustive research in roof control for the protection of personnel and for higher mining efficiency.**

Selecting the Right Man for the Right Job

The second phase of human engineering is our concern for the proper selection of the right people for the right jobs. Russell DeReamer, in his book entitled, *Modern Safety Practices*, states that, "Industrial management must be convinced that lack of *supervisory safety direction*, the *employe's physical condition*, and the *employe's mental condition* cause accidents and that any attempt to control work injuries by the elimination of the accident-prone would be sure to fail."

It was agreed after many years that just taking care of physical hazards contributing to accidents was not enough. Attention was then directed to various training methods for the development of safety awareness or attitude. This constituted a mass educational approach to the mine safety problem. Our safety records indicate that mass approach is not adequate. Certain tests run by large companies in other industries have revealed that mass training does *help* a safety program but group training does not become effective until each employe *knows the hazards of his job and how to avoid them*. The mining industry has relied on group training because it takes very little of the supervisor's time, while personal evaluation, placement, and training require constant activity by the first line supervisor.

To do a good job in personal safety education, it is first necessary to hire the proper people. Then place them in jobs they are qualified to do and, finally, train them. This phase of human engineering is in the realm of industrial psychology or industrial personnel management. It does not follow that because a man has spent years helping on a machine that he will be a good operator or a safe workman. It is also true that all the friends or relatives of the men responsible for hiring are not always the best workmen. It is impossible for men to hire by looking at an applicant or to measure and evaluate the individual with any degree of accuracy. You can see, of course, if he has two hands, maybe you can see if he has two feet, etc., but in today's economy the hiring of men, laying off, or promoting is too costly to be left to trial and error. The term human engineering would imply that some formula can be used to select people. Unfortunately, the selection and placement of people is not nearly as exacting a science as man-machine relationship from a standpoint of design or related engineering aspects of the problem. For instance, can you tell by looking at a man if he would lie or steal? Can you use psychological tests to determine this? Of course, the answer is no.

To fulfill our obligation to the stockholders we need to use every tool available in order to select the very best people to operate our machines and properties. This means trained professional people to set up our selection program for all levels of employment. It has been impossible for the writer to state in all cases just where the company needs this program the worst. It could be that work performance is more easily checked than an executive job performance, so this highly skilled program should start at the top and come down the line to the least important job classification.

North American Coal uses the services of Personnel Research and Development Corp., Cleveland, Ohio, to help it select its people above the level of general mine foreman. The coal company, of course, is responsible for checking the technical knowledge of the applicant.

For the job classification at, and below, general mine foreman, the coal company also uses a well-designed application blank, at least two interviews by the local personnel manager and the superintendent, the applicant's work history, psychological tests and

physical examinations to try and improve its hiring procedures, in order to upgrade its personnel. The extent of psychological tests are determined by the level of job classification. The company has found that at least five applicants should be processed before anyone is hired. It has at times evaluated over a hundred people before hiring at certain levels. Anything that will slow down a hire will help the company obtain a better man. Furthermore, with the very best of selection programs, errors still occur—if for no other reason than the vast individual differences in people.

Even after careful selection, the placement of people is of paramount importance. Great skill is required to build a team. Nine experts on a ball club do not guarantee a fine working team. However, through careful use of human engineering principles, experts of comparable personality, desires, drive, and with proper motivation can be gathered together to promote a good team, efficient and safe.

Method to Educate Foremen on Subject of Safety Program

Human engineering also includes the responsibility of the engineer to educate management on the problems and objectives of a safety program. It is impossible for a foreman to give good direction to an employe until he, himself, understands the problem. The writer, therefore, would like to add to what has already been stated, a method to educate foremen on the subject of a personal safety program.

Have each foreman write a report on each job under his supervision according to the following outline:

1. **Job description.**
2. **Job location.**
3. **Key job steps (work simplification).**
4. **Tools to be used.**
5. **Potential health and injury hazards.**
6. **Safe practices, apparel, and equipment.**

If he can write all of the pertinent information on the above six items for each job, then he is really prepared to enter a complete program in "human engineering" for the safety of his men.

As a personnel administrator, the writer feels that if these facts are applied to each corporate safety program, the coal industry will come into its own as a most progressive, safe, and profitable business.

LARGE COMPANY EXPLORATION

(Continued from page 68)

made by optimistic geologic study of less attractive mineralized areas and peripheral ground, and exploration in regions that appear geologically favorable.

Office compilations of known, meager to fairly comprehensive geologic data, aided by study of colored or black and white aerial photographs and sometimes geophysical data, can help to outline broad target areas. Analysis of general regional structural trends, age and types of rocks and degree of metamorphism, geologic history, and information on known mineral deposits, permit useful deductions.

Broad reconnaissance to check office inferences, and use of soil, sediment, water, or foliage geochemical tests, may help localize areas worth additional work. Application of specific airborne geophysical techniques such as magnetics, or electromagnetics, can establish rock or structural trends and locate conductors. Further study of aerial photographs in the light of the new data may help to guide subsequent ground investigations. Geologic mapping, and specific ground geophysics, such as EM, magnetics, gravity, pulse, self potential, and other techniques are of value in pinpointing targets.

General geologic procedures in exploration should involve sequential steps which, in consecutive order, refine target areas based on prior study and investigation. Each tool of the trade plays a significant part if it is used in conjunction with other tools, the limitations of each being recognized. Careful evaluation of the data at each step permits a fairly logical decision as to the need for further work.

Successful large-company, worldwide exploration results when geological ideas, tempered with political and business considerations, and directed by short and long term company requirements, are a basis of continuing programs. Large companies will usually assume greater exploration risks than small companies when the targets envisioned are sufficiently large to warrant expensive programs, and because immediate success may not be a pre-requisite.

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Aerial view of the Utah Copper Division pit of Kennecott Copper Corp. shows some of the overburden disposal areas above the pit and along the canyon to the right

Practices in Overburden Stripping

By J. V. OTTER
Engineer—Special Services
Morrison-Knudsen Co., Inc.

The key to successful open pit mining is the ability to move overburden economically

GOING back to the beginning of things, men who were seeking gold for the king's coffers or copper for his ancient metallurgy probably burrowed into the earth to mine the ore without regard to the surrounding or overlying cover of earth. Open pit mining with its tremendous growth in recent years represents a complete reversal of the underground approach because the key to success is now the ability to remove the overburden. Mineral values, in a sense, have become secondary to the all-important consideration of how to remove the overlying cover within economic limitations.

Overburden stripping involves much more than simply digging a hole in the ground. Movements of the outer shell of the earth's surface—such as upheaval, subsidence, displacement and fractures and faults in all their variations—over geological time have often altered the original position and structure of ore-bearing formations.

Accordingly, even after mineralized zones are uncovered, the wealth must be sought out by dismantling, block by block, or folding back, layer by layer, the structure of geology within which the minerals occur. Seldom is an unaltered body of mineral of any magnitude found in nature.

Some minerals such as coal occur in layers, where various beds have been laid down with rock and earth between them. At a location in Wyoming there are 21 such layers of coal, each separated by layers of earth and rock formation of various thicknesses; all with a uniform dip of 19°. Some minerals occur in lenses, some as cavity fillings, or as pods without continuity; others, as enrichment zones, with no clear-cut line of demarcation as between overburden and mineral.

As a result, the field of overburden



At Round Mountain, Nev., Round Mountain Gold Dredging Corp. has to excavate up to 90 ft of overburden in some areas to reach the ore body. Haulage equipment in use at this operation includes 17 and 23-yd trucks



Truck dumps ore onto a grizzly which removes oversize and feeds a belt leading to the crusher at Round Mountain, Nev.

stripping often embraces not only the basic work of uncovering the mineralized zone in general, but an entire waste-removal and disposal operation, integrated with the mining operation in such a way as to use to advantage the cavities created where ore is mined out. In this way, the cavities become convenient and economical places to deposit overburden from other sections or blocks of mineral to be mined later.

Example of Integrated Stripping and Mining

An example of this coordinated method of handling overburden removal and disposal is found at the phosphate mine of Monsanto Chemical Co. near Soda Springs, Idaho, where integrated stripping and mining have been carried out for almost ten years. Every possible advantage is taken to limit hauling distance and to utilize downhill instead of uphill movement of material. Each move, in this selective operation, is planned far in advance requiring complete knowledge of the complicated geological structure of the mineralized zones. Here shovels and trucks, tractors, scrapers and other huge earthmoving machines are used, each being strategically moved with the power and ability particular to itself—all with the view of achieving profitable mining operations.

One primary feature that distinguishes all mining efforts from other industries is the fact that mines are using up non-replaceable assets. Although many of the products of mines are recoverable as scrap, and can be used over and over again, no new "crops" will grow to fill the holes where ores have been taken out. The task of technology—and of good management— is to meet the never-ending challenge of increasing natural difficulties, as coal seams grow thinner and mineral yields per ton diminish. As a result, the ratio of overburden removed to mineral recovered has increased, and larger and more efficient equipment for drilling, blasting, and stripping become necessary.

Developments in Drilling Blast Holes

Over the years, there have been gradual improvements in equipment design with occasional spectacular advances such as the substitution of electric power for steam in shovels, and the replacement of rail haulage to a large extent with truck haul. But seldom has there been an advance in equipment and its use comparable with developments of the past few years in the drilling of blast-holes. Churn drilling in many of the larger pits has been replaced, in whole or in part, by rotary tools or percussive tools powered by air.

The rotary was first introduced several years ago for drilling softer rocks found in quarries and coal stripping operations, but the development of carbide-studded roller-cone bits brought wide acceptance in almost every type of open pit mining. Use of this bit, aside from capital cost consideration, is limited only by rocks of such hardness that bit cost defeats its otherwise efficient performance. Rotary drills are available for hole sizes up to 12 in. in diameter. Some models are truck- or tractor-mounted. Large sizes are mounted on heavy-duty crawlers.

Percussive drilling was running second until 1956 when development of down-the-hole- drills caught the attention of excavators and earthmovers. Cuttings are air-flushed, and efficiency, due to the elimination of long drill rod, is increased over previous drills to the point where percussion drilling again became competitive—particularly in the harder rocks.

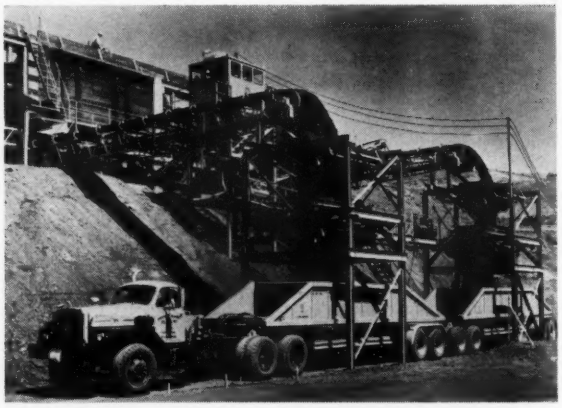
One of the most outstanding developments in blasting procedure since black powder has been the application of ammonium nitrate as a blasting agent. Improvement in the methods for use of prilled ammonium nitrate have been continuous, and where ground conditions permit, its use has become almost universal.

Ammonium nitrate mixed generally with six to eight percent, by weight, of fuel oil has proved itself a safe, efficient blasting agent. It is adaptable in a wide variety of conditions and where it can be used, provides substantial cost reduction in an important and often expensive phase of overburden stripping.

Trend is to Larger Stripping Equipment

Although less spectacular, developments in haulage equipment have continued, and several interesting new units have appeared. The trend to larger rear-dump and trailer-type trucks has continued to where 35 to 50 ton trucks are not uncommon.

Engine horsepower trend is up-



A 72-ton capacity bottom-dump truck is shown receiving phosphate ore from a twin-loading tipple. The 105-ft long truck will transport the ore at 50 mph to Monsanto's processing plant at Soda Springs, Idaho

ward, in keeping with larger trucks and demand for higher performance. Torque converters are available for almost all trucks and automatic transmissions are common, although standard transmissions are still finding general use. Horsepower increase, in some instances, has come through use of superchargers and turbochargers on standard engines.

Push-loaded by large tractors, and preceded by rippers where necessary, tractor and scraper units in sizes up to 35 cu yd and larger continue to turn in excellent performance under conditions suited to their use. As scrapers have grown in size, tractors have necessarily grown with them.

Substantial improvement in tire life has come about through use of heavier tire carcasses, of 30 plies and over, combined with extra tread rubber.

Interest in larger loading equipment continues, and as stated by one operator in the coal stripping industry, "No one ever made the mistake of buying too large a power shovel."

In truck haul pits, where large tonnages justify the capital expenditure, conveyor and skip-hoist installations for elevating the ore from the pit bottom to the surface are popular because of proven low haulage cost and reliability. Wheel excavators are operating in some locations as an auxiliary machine, removing overburden in conjunction with a stripping shovel.

There is certainly no lack of well-designed, efficient machinery to do almost any job, large or small, and the effect of this on overburden stripping operations is obvious. Allowable stripping ratios have been increased; open-pits have been economically deepened; methods have been improved and will improve further as new machinery and new applications are developed. However, the problems of choice of equipment and method of use still remain with the stripping operator.

Material to be Moved Governs Equipment Selection

Overburden stripping is a highly specialized operation calling forth the best on the part of advance planners and the skill and ingenuity of all concerned. No two stripping operations are alike due to variations in nature, but all have this in common: the overburden material must be excavated, transported, and disposed of—it is essentially a dig-it, haul-it, dump-it operation.

The operator must concern himself with the best methods and equipment to perform each of these functions for the given undertaking. One of the first considerations is the quantity of overburden to be removed. Large quantities permit the write-off of depreciation on large and expensive machines. Operations involving smaller quantities of material must of necessity be carried out with less expensive equipment. The rate of production is also a governing factor because it determines the capacity of machines, the numbers of units which must be employed to accomplish the given quantities within specified time limits.

Consideration must be given to the thickness of overburden to be removed. It is also important to know whether the pit is generally below the level of the surrounding ground or up on a mountain top where the material can simply be pushed aside. For some pits, the disposal of surface run-off and ground water becomes a problem because of the necessity of pumping.

The kind of material to be removed will govern whether it can be taken up with tractor and scraper units or must be ripped or drilled and blasted. Generally it is conceded that it is more economical to rip than to drill and shoot. Abrasiveness of the material is a factor having a bearing on tire wear and cost of operation of rubber-tired vehicles.

Equipment for transporting overburden from the point of origin to a disposal area is determined primarily by the length of haul, the differences in elevation, whether the movement is up-grade or down-grade, and the steepness of these inclines. The operator, of course, has some leeway in construction of haul roads, wherein the rate of grade can be reduced at the expense of increasing the length of the haul. However, there is always the over-riding consideration that the overburden must be taken from one elevation and deposited in another, all of which can be converted into foot pounds of energy required. In this connection, the stripper must know how to make a road that is neither so sturdy that it is overly expensive, or so flimsy that it will not carry the load.

In planning for disposal of the waste material, one must know whether conditions permit dumping in open or confined quarters. Under confined conditions, cost of secondary movements such as dozing may be involved, whereas under open and downhill conditions there is no secondary expenditure.

Effect of Climatic Conditions on Operations

In addition to selecting the best methods for a given stripping job and picking out equipment best suited



An example of selective-type open pit mining is Monsanto Chemical Company's phosphate mine at Soda Springs, Idaho, where integrated stripping and mining have been carried on for ten years



Originally an underground operation, the Elkol mine of Kemmerer Coal Co. in western Wyoming was converted to strip mining in 1950. Rotary drills, tractor-drawn scrapers, end-dump trucks, and a dragline are among the equipment used. Nearly 6,000,000 cu yd of overburden have been removed from this pit

to each of the functions involved, the operator should be alert to the fact that nature yields her riches grudgingly. Hazards of climate are to be reckoned with. Winter may, for instance, clamp down so tightly that operations come to a standstill and remain dormant for several months. Wind may lift belts from conveyors and render operations impractical unless protective covering has been provided. Abrasive material chews up tires. Dust takes its toll in terms of mechanical wear and reduces the operating life of internal combustion engines. Extremes in temperature—excessive heat or cold—reduce operating efficiencies of both men and machines.

Overburden stripping, however, has proven its merit as a way to get many mining jobs done within the strict confines of economic limitations, and the field of overburden stripping has grown to tremendous proportions as the art and science of rearranging the earth's outer shell is perfected. It exceeds in magnitude, when measured by weight or volume, the greatest construction achievements of all times. The millions of cubic yards of overburden removed from mineral deposits this year, for instance, will far exceed the quantity of embankments placed in the form of large dams built during the same period.

As it becomes economically feasible for mine operators to increase the ratio of overburden removed to mineral recovered, the quantity of stripping mounts into the millions, and even larger millions, of cubic yards. This, in turn, makes practical larger excavating equipment and better methods, and the result is an ever-expanding cycle, motivated by economic gain—always hoped for and often realized.

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San Francisco, Seattle
Toronto, Tulsa

Operators' Corner

Increased Drilling Speed With a Concave Bit*

A newly designed rock bit, being tested in South African gold mines, is expected to reduce drilling costs

A recent advance in tungsten carbide drill bit design offers a number of advantages over the conventional chisel bit.

The new product, known as a "saddleback" tip, originated from research at the University of the Witwatersrand, under Dr. H. H. Schlossin. The work was done by Hard Metals, Ltd., at Springs, near Johannesburg, and thorough tests in gold mines in the area confirmed the practical value of the new design.

These tests have shown that drilling speed is greater than with conventional bits; that because of the shape of the tip, it is subject to less wear; that, as wear is reduced, there is less likelihood of insert failure; and that coarser sludge particles are produced. All of these factors reduce the cost per foot drilled.

The accompanying illustration shows that the cutting edge of the saddleback tip is concave; in the conventional type, shown for comparison, it is convex. The shape was chosen to satisfy the three basic requirements of the drilling process: (1) That drill energy is transferred efficiently to the rock; (2) that there is a minimum of wear, so that high speed drilling can be maintained without frequent interruption for sharpening; and, (3) that cuttings are cleared away quickly.

The impact energy of a percussion drill is conveyed to the rock through the drill steel in the form of stress waves. Research has shown that this energy is most efficiently transmitted when the cutting edge or "energy transfer surface" consists of two diametrically opposed circular segments (when viewed in plan).

The profile of the cutting edge was designed to reduce wear. It was found that the mathematical condition that satisfied the requirements of an efficient tip was a parabolic shape. This concave design was, therefore, used in the cutting edge as well as the cutting surface and the bit shoulder. Continuation of the parabolic profile gave a natural concave form to the flanks of the bit, and this facilitated the clearance of cuttings and minimized bit wear.

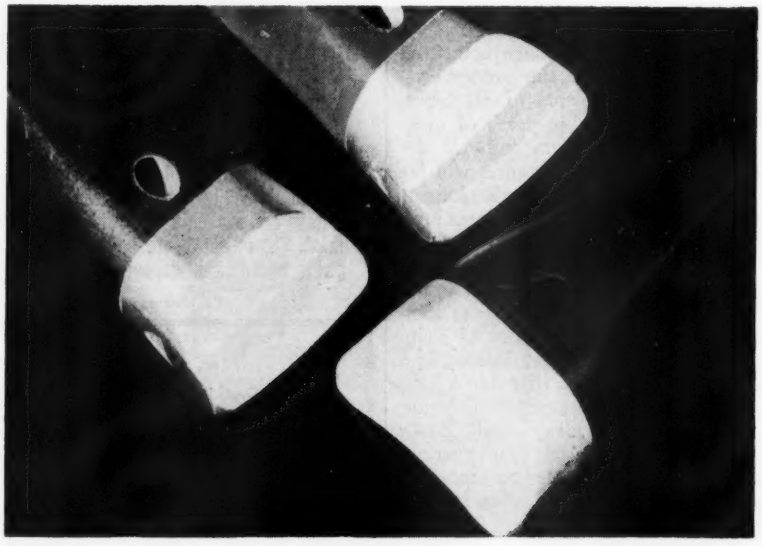
Performance of the new tip indicates that drill energy is transferred more efficiently to the rock, which is thereby fractured more easily and effectively, resulting in coarser cuttings and proportionately less dust.

The new shape tends to focus the stress waves within the cylindrical volume of rock that is being drilled, and this energy is concentrated in the formation of a hole, instead of being dissipated in other directions.

Because the concave bit maintains a higher speed of penetration than the convex type and is more resistant to wear, it can be used for longer periods before regrinding becomes necessary, and thus the footage drilled with each rod is increased.

Regrinding of the tips is by means of a specially designed grinder.

The cutting edge on the saddle back tip (right) is concave as compared to the convex cutting edge on conventionally designed bits (left)



* *Condensed from Optima, a quarterly review published by Anglo American Corporation of South Africa.*



As Viewed by HENRY I. DWORSHAK of the American Mining Congress

TWO of the Administration's major economic proposals have been approved by Congress and signed into law by President Kennedy. One of these, the Area Redevelopment Act, establishes a $394 million program to aid chronically depressed areas—primarily through three $100 million loan funds to encourage construction or expansion of industrial and public facilities.

The other measure would raise the $1 hourly minimum wage to $1.25 in stages and extend its coverage to about 3.6 million additional workers. Earlier this year Congress and the President approved legislation extending the duration of unemployment compensation benefits up to a maximum of 39 weeks.

Interior Secretary Udall has announced that two top-level career officials of the Department will remain in their positions. They are Marling J. Ankeny, director of the Bureau of Mines, and Thomas B. Nolan, director of the Geological Survey. Both have headed their respective agencies since 1956.

★ ★ ★ ★ ★ ★

Washington Highlights

CONGRESS: Kennedy program moves ahead

TAXES: Hearings begin on Administration proposals

FUELS STUDY: Endorsed by Interior Department

LEAD-ZINC: Subcommittee holds "exploratory" hearing

WATER POLLUTION: Blatnik bill passed by House

MERGERS: AMC witness opposes prior notification bill

SAFETY: Small coal mine bill approved by Committee

GOLD: Subsidy bills slated for hearings

SILVER: Hike in Government selling price urged

★ ★ ★ ★ ★ ★

HOUSE COMMITTEE STUDIES PRESIDENT'S TAX PROPOSALS

The Ways and Means Committee is now holding hearings on President Kennedy's recommendations for tax changes. These include extension of the 52 percent rate on corporations, repeal of the 4 percent credit and $50 exclusion on dividends received by individuals, withholding of Federal income tax on dividends and interest, denial of deductions for entertainment expenses together with other restrictions in the "expense account" field, increasing the tax burden on income produced abroad—particularly in the "economically advanced" countries, repeal of capital gains treatment to the extent of depreciation previously taken when property used in business is sold, and establishment of a system of "taxpayer account numbers" to help enforcement.

The President also recommended a tax credit device to stimulate investment in new equipment. The proposed credit would be equal to 15 percent of the amount of the current year's investment in new equipment which exceeds the current year's depreciation allowance, plus 6 percent of the current investment to the extent it is between half and all of the current depreciation. The credit would be limited to 30 percent of the tax due, with carry-forward for unused credit as well as deficits.

Lincoln Arnold, chairman of the American Mining Congress Tax Committee, will present the industry's views to the Ways and Means Committee. AMC will object to the elimination of capital gains treatment on depreciable business property unless it is accompanied by more realistic depreciation allowances.

In addition, the Mining Congress will urge the retention of the dividends-received credit and exclusion as well as the deferral of tax on income earned abroad until its repatriation.

President Kennedy indicated to Congress that this year's recommendations constitute merely a "first step" in tax revision, and said that he expects next year to present a comprehensive program for "broadening the tax base" which will be prepared by the Treasury on the basis of past studies.

NATIONAL FUELS STUDY WINS DEPARTMENT APPROVAL

The Interior Department endorses a proposed National Fuels Study by a special Senate Committee and stands ready to make available a "wealth of information," Interior Secretary Udall announced May 4.

He wrote Chairman Anderson (Dem., N.M.) of the Senate Interior Committee that a "balanced fuels and energy study which gives full weight to consideration of national defense, the needs of our domestic economy, and considerations of international trade and diplomacy would assist both the Congress and the Administration in developing future policies and programs."

An objective study which would bring together the sum total of available information in this sphere "would be of immense value to the future of energy development in the United States as related to national security and the accelerated expansion of our economy," Udall stated.

The Nation's coal industry has long sought a Congressional study of this type.

LEAD-ZINC PROBLEMS AIRED AT SENATE HEARING

Spokesmen for lead-zinc miners and smelters suggested subsidies and higher tariffs on imports as remedies for the depressed condition of the domestic industry at an "exploratory" Senate hearing May 4.

Robert McConnell, assistant to John M. Kelly, Assistant Interior Sec-

retary for Mineral Resources, and other Department witnesses said that recent declines in domestic consumption of the two metals had helped negate the effect of the 2½-year-old import quotas, which limit annual imports of lead and zinc to 80 percent of average annual imports during 1953–1957. They attributed much of the decline to increased use of plastics and the advent of compact automobiles.

They also said that the Department is working on proposals to aid the ailing industry and may submit its recommendations about May 15.

Clark L. Wilson, chairman, Emergency Lead-Zinc Committee, urged enactment of the Aspinall-Anderson bill as a permanent solution of the industry's problems. This measure calls for a limited subsidy paid from tariff receipts and higher import taxes on both metals—2 cents per pound on a permanent basis and an additional 2 cents which would be applicable when prices fall below 13½ cents per pound in the case of either metal. He said this measure "recognizes the interests of the consumer and the importer and the provision for protection adjusts to world prices and domestic needs."

Richard A. Young, vice president, American Zinc, Lead & Smelting Co., who represented five smelting companies, stated that a 4-cent import tax would raise lead-zinc prices to a point where markets would be lost to competitive materials. In response to a question, he suggested that the industry's troubles could be corrected by a reasonable increase in tariff rates, but did not suggest a specific amount of increase.

Both Wilson and Young opposed barter of surplus agricultural commodities for foreign lead and zinc as a means of reducing world stocks of the metals.

Tom Kiser, president, Tri-State Zinc & Lead Ore Producers Association, urged enactment of the Edmondson-Kerr bill to aid small producers. This measure would provide subsidy payments on up to 2,000 tons of each metal annually, to give producers the equivalent of the difference between what they actually receive and what they would have received at prices of 17 cents for lead and 14½ cents for zinc.

Fred Jeffrey, president, National Zinc Co., a smelter which owns no mines, said that the import tax rates proposed by the Aspinall-Anderson bill were too high and would make it difficult to procure needed quantities of foreign concentrates. He suggested, however, that a reasonable increase in tariff rates is necessary.

WATER POLLUTION BILL APPROVED BY HOUSE

By a vote of 307 to 110 May 3, the House passed the Administration-endorsed Blatnik bill to greatly expand the Federal Government's role in water pollution control. The measure is now being considered by the Senate Public Works Committee.

The present Water Pollution Control Act limits Federal pollution abatement authority to interstate waters. The Blatnik bill would extend this authority to all "navigable" and coastal waters, whether or not there is a showing of interstate pollution, if abatement action is requested by a State. Thus, for all practical purposes, the new Federal enforcement provisions would apply to all waters in every State.

Other provisions of the measure would authorize the Secretary of Health, Education and Welfare to issue final abatement orders (subject to appeal to Federal appellate courts), and permit higher expenditures of Federal funds—up to $100 million annually—to help finance construction of municipal and other public waste treatment works.

In recommending the bill's enactment, the House Public Works Committee report said that acid-mine drainage from abandoned coal mines in many areas of the country "has been causing an increasingly serious pollution problem." To combat this problem, the Committee suggested that the Secretary of H-E-W undertake a comprehensive study of the nature and scope of acid-mine drainage from abandoned coal mines and "report to the Committee within a year with recommendations for appropriate action."

Such suggestions are normally followed by the Executive Department or agency concerned.

PREMERGER NOTIFICATION BILL OPPOSED BY AMC WITNESS

Legislation to require 60 days' advance notice to the Government of proposed corporate mergers or acquisitions is "wrong in principle" and would interfere with ordinary business operations, a mining industry spokesman testified at a House Judiciary subcommittee hearing this month.

Fred W. Peel, a Washington, D. C., attorney who appeared on behalf of the American Mining Congress, told the subcommittee that such a law "would be a blind, indiscriminate barrier to acquisitions of business properties by medium and large corporations. It would hamper mergers, and other types of acquisitions as well, without regard to whether they are good or bad, helpful or harmful to the country or to the maintenance of healthy competition."

Spokesmen for the Justice Department and the Federal Trade Commission had testified earlier that the prior-notice law is needed to give the Government time to study proposed mergers and acquisitions to see if they might violate the antitrust laws by substantially lessening competition.

Peel pointed out that a mining company's mineral reserves have exactly the same economic function as the stock-in-trade on the shelves of a grocery store, and a ton of minerals must be acquired to replace each ton that is taken from the ground. He added: "Essentially, the acquisition of undeveloped or partially developed mineral properties merely affords the means by which the industry can continue to produce the basic products which we all use and need every day, and such acquisitions do not have the effect of lessening competition or of tending toward monopoly."

The AMC witness noted that the bill under consideration contains an exemption of acquisitions of undeveloped or partially developed mineral or mining properties and of the stock of corporations 75 percent or more of whose assets consist of undeveloped or partially developed mineral or mining properties. Peel said the mining industry is gratified that sponsors of the legislation have recognized, by this exemption, that mining is a wasting-asset industry, and urged its retention if any premerger notification bill is reported to the House.

SMALL COAL MINE SAFETY BILL AWAITS HOUSE VOTE

The House Labor Committee has approved a bill which would extend the enforcement provisions of the Federal Coal Mine Safety Act to mines normally employing less than 15 persons. The measure, introduced by Rep. Dent (Dem., Pa.), may come up for a House vote at any time.

Under the Act, the Director of the Bureau of Mines has power to shut down larger coal mines if he finds that safety conditions do not meet prescribed standards. Any mine thus closed cannot be reopened until the unsafe condition is corrected. Dent's bill would make small mines subject to closing by the Director, but would

(Continued on page 82)

personals

George A. Lamb has been sworn in as the first permanent director of the Office of Coal Research, Department of the Interior. He has been manager of business surveys, Consolidation Coal Co., for the past 15 years. Lamb is a former assistant director of the Bureau of Mines. He joined the Department of the Interior in 1938 as a mineral economist in the Bituminous Coal Division. Subsequently he served as chief, economics branch; chief economist, Solid Fuels Administration, and assistant director of the Bureau. He has also served the coal industry in various industry-wide committees and as consultant to the Cabinet Committee on Energy Supplies and Resources Policy in 1954. **Don Gasper,** who has been with Consol since 1951, succeeds Lamb as manager of business surveys.



G. A. Lamb

Frank R. Milliken has been elected president of Kennecott Copper Corp. succeeding **Charles R. Cox,** who has been president for 11 years. Cox will continue as a director and member of the executive committee.



F. R. Milliken

Milliken was formerly executive vice president, assuming that position and membership on the board of directors in 1958. For the previous six years he had been vice president in charge of mining operations. In 1935 Milliken joined Peru Mining Co. as a metallurgist. He later became chief metallurgist for General Engineering Co. of Salt Lake City and an experimental engineer with Kennecott's Utah Copper Division. From 1941 to 1952, he was with National Lead Co., first as plant manager of the MacIntyre Development and then as manager of the Titanium Division. Milliken received the Robert H. Richards award of AIME in 1951 for his contributions to the minerals industry.

E. J. Behn has been named chairman of the board and **C. J. Lakin** president of both the Berwind-White Coal Mining Co. and New River and Pocahontas Consolidated Coal Co. They were formerly vice president and executive vice president, respectively, of these companies.

S. H. Williston, executive vice president of Cordero Mining Co., has been elected president of the American Quicksilver Institute. **C. Hyde Lewis,** president of New Idria Mining and Chemical Co. was named vice president.

James Hyslop, president of Hanna Coal Co., Division of Consolidation Coal Co., has been awarded an honorary Doctor of Laws Degree at Marietta College, Marietta, Ohio. Hyslop entered the coal industry as a mine laborer at age 13 and became senior electrician in a fully electrified mine at 16. From 1926 to 1940 he was with Walter Bledsoe & Co., first as chief electrical and mechanical engineer and later as general manager of operations. He joined Hanna Coal Co. in 1940 as general manager and was named president of the division in 1950.

Charles S. Payson has been elected chairman of the board of Vitro Corp. of America. He succeeds **J. Carlton Ward, Jr.,** who has resigned. Payson has been associated with the Vitro group of companies since 1949, having helped organize what is now Vitro Corp. of America. He has been a member of the board of directors since its formation.

J. Philip Murphy has been elected president of Yuba Consolidated Industries, Inc., succeeding **John L. McGara,** president and chairman of the board, who has resigned. Murphy, former president of Judson Pacific-Murphy Corp., which merged with Yuba in 1957, also becomes a director of the company.

Arnold E. Lamm, president of Pittsburg & Midway Coal Mining Co., and several operating officers are moving their offices from Pittsburg, Kan., to Kansas City for integration into the general offices of the parent company, Spencer Chemical Co. Other officials involved in the move immediately are **Frank J. Foresman,** director of public and employe relations, and **John Plump,** operating manager. In the months ahead, all corporate staff functions of Pittsburg & Midway will be transferred to Kansas City.

Bernard Ulrich, former executive vice president of St. Lawrence Cement Co., has been named president and director of Atlantic Cement Co., Inc., a joint subsidiary recently formed by Cerro Corp. and Newmont Mining Corp.

Earl J. Evans has been renamed president of the Utah-Wyoming Coal Operators Association and **H. J. Shultz** was named vice president. Evans is vice president and controller of Royal Coal Co. and Spring Canyon Coal Co. Schultz is vice president and general manager of Western Coal Mining Co.

Fred L. Doolittle, previously executive vice president, has been named to succeed **Barton W. Druckenmiller** as president of Penn-Dixie Cement Co. Druckenmiller, who has been with Penn-Dixie since 1929 and president since 1945, has been elected chairman. The chairmanship had been vacant for seven years. Doolittle has also been with the company since 1929, having been executive vice president and a director for the past five years.

John G. Partch has been appointed director of chemical development in the Research and Development Department, North American Coal Co.

Jack W. Buford has been advanced to the newly-created post of manager of South American Operations, Hanna Mining Co. He will also continue as assistant vice president, operations. Buford joined the company in 1950 and had a key role in development of the Quebec-Labrador iron ore fields of Iron Ore Co. of Canada, in which Hanna has an interest. He was previously affiliated for 15 years with the Pennsylvania Railroad.

Hanna also announces that **Ernest L. Ohle** has been appointed staff geologist for the company. Formerly vice president and chief geologist of Copper Range Co. and White Pine Copper Co., Ohle had earlier been a geologist with American Zinc, Lead and Smelting Co. and St. Joseph Lead Co.

Norman A. Radford has joined Trout Mining Co. as geological engineer at the company's Philipsburg, Mont., operations.

Lester F. Bishop, chief research engineer, Mining Research Department, and **Wallace A. O'Brien,** mines geologist for the Anaconda Co. at Butte, Mont., have retired. Each started his career in the mining industry over 40 years ago. Bishop developed the modern "bunch" blasting method in the Butte mines, and O'Brien is credited with a geological study which led to the discovery of a large ore body and revival of the St. Lawrence mine for several years. Both joined Anaconda as miners while attending college.



W. A. O'Brien



L. F. Bishop

Stewart W. Hurlbut, staff industrial engineer since December 1960, succeeds Bishop as chief research engineer, Mining Research Department. Hurlbut has been with Anaconda for 14 years. He joined the company as a sampler, became a mining engineer in 1948, and entered the research department in 1956.

James D. Moore has become manager of Western Operations, Vitro Chemical Co. He had been manager of the company's Salt Lake City plant having been advanced to that post in 1957 from production manager. As manager of Western Operations, Moore will have over-all management responsibility for mining, manufacturing, purchasing, personnel, and administration.

John H. Klas has been appointed director of public relations, Utah Copper Division, Kennecott Copper Corp. He was formerly executive director of the Utah Petroleum Council.

S. A. Scott has been appointed chief mining engineer and **Frank C. Pickard** manager of prospect development in the Mining and Exploration Department, International Minerals & Chemical Corp. Scott will continue to act as shaft sinking superintendent at IMC's Esterhazy, Saskatchewan, potash project until its completion. Pickard has been project engineer at the Esterhazy development for the past four years.

The company also announced the appointment of **Donald H. Freas** as geologist and **David M. Williams** as mining engineer. Freas comes to IMC from Arizona State University, where he has been a geology professor. Williams joins IMC after six years with Rio Algom Uranium Mines in Elliott Lake, Ontario.

David R. Mitchell has become dean of the College of Mineral Industries at Pennsylvania State University, after serving as acting dean since the resignation of **O. F. Tuttle** in November 1960. Mitchell will continue as chairman of the Division of Mineral Engineering and professor of mining engineering.

M. S. Bell has succeeded **Earl W. Donahue** as works manager at the El Paso Refinery of Phelps Dodge Corp. Donahue has retired. Bell, former assistant works manager, has been succeeded by **H. A. Shaw.**

F. M. Chace, who has been serving as assistant director of exploration, Hanna Mining Co., has been named acting director of exploration.

Ted Bush, former deputy mine inspector for the State of Idaho, has joined Bunker Hill Co. as assistant to the health and safety supervisor.

Arthur Gloster, formerly chief engineer of Titlestad Corp., has joined Texas Gulf Sulphur Co. as assistant manager of research. Gloster for the past five years has specialized in the design of sulphuric acid plants.



Edward Thiel has been appointed assistant professor of geophysics in the School of Mines and Metallurgy at the University of Minnesota. He was the principal investigator of the Antarctic Oversnow Traverse Program and project leader of the Antarctic Data Analysis Center, administered by the University of Wisconsin. In addition to his teaching and research duties, he will continue with Antarctic research as chief scientist of the 1961-62 airborne geophysical program.

W. G. Jones, forestry consultant of Philipsburg, Pa., has been appointed director of conservation for the Central Pennsylvania Open Pit Mining Association. Jones will have, among other duties, responsibility for assisting association members in reclamation and planting problems.

Michael P. Mehan, chief of the former Concentrate Procurement Branch, Grand Junction, Colo., Operations Office, Atomic Energy Commission, is retiring after nearly 20 years in Government service.

OBITUARIES



Alfred J. Cayia, retired president of Caland Ore Co., Ltd., subsidiary of Inland Steel Co., and Inland Lime & Stone Co., a division of Inland Steel, died April 2 at Manistique, Mich.

Mr. Cayia had retired in 1957. In 1956 he was Lake Superior district chairman of the program committee for the American Mining Congress Mining Show in Los Angeles.

John Paul Dyer, 76, former vice president of Phelps Dodge Corp., died in Short Hills, N. J., March 20. He had been a Vice President of Phelps Dodge from 1935 until he retired in 1950 after 25 years with the company. Earlier he had been associated with the Guggenheim copper interests in Chile for ten years.

Roscoe H. Channing, 93, retired president of Hudson Bay Mining and Smelting Co., Ltd., died in Tucson, Ariz., April 1. Mr. Channing was also a former president of Cerro de Pasco Copper Co. and Consolidated Copper Co. and had been a director of Magma Copper Co.

Cecil A. Fitch, 75, retired president and general manager of Chief Consolidated Mining Co., died April 16 in Salt Lake City.

Mr. Fitch with his father and brother developed mining properties at Eureka, Utah, which in 1909 became the Chief Consolidated. In 1937 he was named president of the company, which post he retained until retirement in 1956. He served as a consultant to the company following retirement.

Carl Otto Anderson, 65, president of Ozark-Mahoning Co., died in Tulsa, Okla., April 13. Mr. Anderson had been president of Ozark-Mahoning for eight years, having joined the company 35 years ago.

Raymond R. Knill, administrative assistant—production, Potash Co. of America, Carlsbad, N. M., died March 25. Mr. Knill was promoted from general superintendent in January having been with PCA since 1945. Earlier he had worked for Union Pacific Coal Co. in Wyoming and the National Safety Council in Chicago.

NEWS and views



Udall Addresses NCPC Dinner

Stewart L. Udall, Secretary of the Interior, expressed strong support for pending Congressional resolutions to authorize a National Fuels Study in a speech at the annual dinner of the National Coal Policy Conference, held in Washington, D. C., March 29. He said ". . . The Administration wants a type of long-range study, a balanced study, that will look into this subject very thoroughly and will use the only yardstick and the only test that I think your industry wants, and that is what is good in the long run for the country. This is what the President wants. This is what the Department of Interior wants." In closing, he declared that the Administration will go just as far as it can in helping the coal industry to achieve its proper goals.

The Secretary was introduced to a large audience of members of Congress, Government officials, and representatives of industry and labor by George H. Love, board chairman, Consolidation Coal Co., and chairman of NCPC.

In a short speech, Love told the audience that an additional 100,000,000-ton market could be captured for coal if imports of residual fuel oil into the East Coast market are held to a reasonable level and if the growing practice of dumping natural gas under steam boilers "where the job can be done and is generally done by coal" is ended.

Love said that such an additional market would "put at least 50,000 heads of families back to work," and add over $200,000,000 to coal mine payrolls, $75,000,000 to payrolls of companies which would supply $150,000,000 of new equipment and machines, and $125,000,000 in wages for railroad workers. The revenue of Eastern railroads would be increased by $250,000,000, he added.

The long-range answer to the domestic fuels economy, Love said, lies in a Congressional study of the Nation's energy resources and a National Fuels Policy which he predicted would result from such a study.

John L. Lewis, president emeritus of the UMWA, also addressed the group, warning that the fate of America and the rest of the free world depends on the vitality of America's basic industry—coal.

New Salt Mine Scheduled for Louisiana

Belle Isle, reputed to have been an outpost during the early 1800's for the pirate Jean Lafitte, will soon be the scene of new activity. Cargill, Inc., has announced that it will develop a salt mine on this historical bit of land about 15 miles from Morgan City, La.

A 1300 ft shaft will be sunk to develop a salt deposit which was discovered in 1896. The crucial phase will be the driving of a 16 ft circular shaft through water bearing strata overlying the salt deposit. Shaft freezing methods will be used to get the shaft down to the salt.

Processing and storage facilities will all be underground, in the mine. The only surface installations will be a 400-tph hoist and a conveyor system for delivering salt to a nearby barge loading dock.

Indiana Coal Mining Institute Holds Annual Meeting

Ralph Whitman, superintendent of Ditney Hill mine, Ingle Coal Co., presided at the annual meeting of the Indiana Coal Mining Institute on April 8 at Terre Haute. The program included talks on "Fire Resistant Hydraulic Fluids for Mine Equipment," "No. 22 Mine Fire, Island Creek Coal Co.," "A General Evaluation of Continuous Miners," "German Brown Coal Mining with Bucket Wheel Excavators," and "Evaluation of New Fire Fighting Techniques." At the annual business meeting, Michael Kensek, chief safety engineer, Enoco Collieries, Inc., was elected president for 1961–62, succeeding Whitman.

Iron Range Found In Central America

A new iron range has been discovered on the west coast of Costa Rica by A. W. Dugan, engineer from Houston, Texas. Named Huacas Iron Range, the discovery has been conconfirmed by leading geologists and the Costa Rican Bureau of Mines. The largest series of deposits occur in the Province of Guanacaste within one to five miles from the Pacific Ocean and suitable shipping and loading points. Claims on the area have been granted to International Iron of Costa Rica, which is conducting the exploration, evaluation and development planning.

N&W and C&O to Buy Island Creek Barge Line

The Norfolk and Western Railway Co. and the Chesapeake and Ohio Railway Co. have announced plans for joint purchase of the assets of Island Creek Fuel and Transportation Co., a coal-carrying barge line operating on the Ohio River. The two railroads will pay approximately $8,000,000—$4,000,000 each for properties of the wholly-owned subsidiary of Island Creek Coal Co. A contract for the transaction has been signed, subject to approval by the Interstate Commerce Commission.

Economics of New Coal Pipeline Appear Favorable

A research program aimed at improved metallurgical coke and major progress in transporting solid coal through a pipeline are major developments disclosed in Consolidation Coal Company's annual report.

The company reported that a new joint research program with two of its

(Continued on next page)

(Continued from previous page)
steel customers was started in 1960. This effort is aimed at perfecting a process to provide a coke of superior structural and chemical characteristics.

In discussing the successful operation of Consol's first coal pipeline in Ohio, the report commented that continuing research has improved preparation of the slurry so that it can now be handled like a liquid fuel. Thus the present expensive dewatering plant can be eliminated. Exhaustive tests by manufacturers of furnace equipment have definitely proved that this "stabilized slurry" can be satisfactorily burned in cyclone burners, and, with certain adaptation, in present day pulverized fuel plants.

Together with Texas Eastern Transmission Corp., Consol has been working closely with a group of Eastern utilities looking towards the construction of a line from its northern properties to the Eastern Seaboard area. According to the report, economics of such a line appear to be favorable. There are other routes where pipeline transportation appears to offer opportunity for substantial savings and these contacts are being developed as rapidly as practicable.

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Cerro Corp. and Newmont Mining Corp. have announced plans to build a 10,000,000 bbl per year cement mill in Ravena, N. Y., 12 miles south of Albany. Over 2000 acres of land in that area are under option and will provide a plant site, a loading station for ocean-going vessels on the Hudson River, and limestone reserves adequate to sustain production for over 100 years. Production is expected to begin early in 1963.



The mill, which will initially use two large kilns, is designed to produce 10,000,000 bbl per year, with provision for later expansion to as much as 20,000,000 bbl annually. The limestone quarry will be located about 3000 ft west of the plant site. Crushed rock will be brought by conveyor to the mill, which will employ the conventional wet process for making cement. Other raw materials and fuel can be delivered to the mill by water, truck or rail transportation. Two grades of limestone will be crushed and blended before final grinding for kiln feed to produce cement clinker. Clinker will be stored at the plant site and ground into finished cement as needed. The finished product will be sent to the river-front loading station by a 7000-ft conveyor. About $64,000,000 will be invested in land, mill, distributing stations, engineering and working capital.

A new company, Atlantic Cement Co., Inc., will construct and operate the plant. Cerro and Newmont will each own a 45 percent stock interest in Atlantic with ten percent of the stock held by others.

WHEELS OF GOVERNMENT

(Continued from page 78)

give him authority to exempt any mine or class of mines from the enforcement provisions where he finds that they do not substantially contribute to the safety of men working in such mines.

GOLD SUBSIDY BILLS SCHEDULED FOR HEARINGS

Late last month the House Interior Subcommittee on Mines and Mining announced it would hold hearings May 8 and 9 on proposed legislation aimed at encouraging domestic gold production through incentive payments.

The announcement said the Subcommittee would consider two types of proposals. One of these would authorize the Secretary of the Interior to determine the amount of subsidy, but not to exceed $35 an ounce, with a five-year limitation on the program.

The other would authorize the Secretary to pay $20 an ounce on gold from currently producing gold mines and on by-product gold, and $35 an ounce on gold from mines which are reopened as a result of the incentive payments or which are discovered or developed after the bill's enactment. The $35 an ounce subsidy would drop to $20 after 10 years of operation of a new or reopened mine.

TREASURY SILVER PRICE ADJUSTMENT IS URGED

Senator Bennett (Rep., Utah) has urged Treasury Secretary Dillon to increase the Government's selling price of silver—91 cents an ounce since 1946—in order to stem the steady drain on Treasury stock of "free" silver, or silver in excess of monetary reserves. The world market price is somewhat higher.

In a letter to Dillon, the Senator noted that world consumption of silver is exceeding production by a considerable margin. "This gap has been largely filled by Treasury sales of free silver," he stated. "If this process continues at the present rate, it is obvious that the Treasury's free silver stock will soon be exhausted."

Bennett's letter added: "When the Treasury no longer has silver to sell, the world market prices will be relieved by this artificial dampening influence, and will probably react violently. The domestic silver producers feel that it would be better for all concerned if the Treasury adjusted its sales price to the world market now, while the two prices are not very far apart."

THE REPORT CORNER

Recent Publications of Interest to Mining Men

USBM IC 8010. "Comparative Evaluation of Coking Properties of Four Coals," by Staff, Division of Bituminous Coal. Supt. of Documents, Government Printing Office, Washington 25, D. C. Price: 25 cents.

Metals Handbook, 8th Edition, Vol. 1, "Properties and Selections of Metals." American Society for Metals, Metals Park (Novelty), Ohio. Price: $30.00.
Note: A 32-pg. illustrated brochure describing the ASM Metals Handbook is available free.

"Mineral Resources of Colorado—First Sequel." Colorado State Mineral Resources Board, 204 State Office Bldg., Denver 2, Colo. Price: $5.00.

USGS Professional Paper 373, "Aerial Photographs in Geologic Interpretation and Mapping," by Richard G. Ray. Superintendent of Documents, Government Printing Office, Washington 25, D. C. Price: $2.00.

"Drilling and Blasting Symposium." Vol. 56, No. 1. Quarterly of the Colorado School of Mines. Dept. of Publications, Colorado School of Mines, Golden. Price: $4.00.

"Three Studies in Minerals Economics," by Orris C. Herfindahl. Resources for the Future, Inc., 1775 Massachusetts Ave., N.W., Washington 6, D. C. Price: $1.00.

USBM RI 5724. "Smelting Taconite in the Bureau of Mines Experimental Blast Furnace," by Miles B. Royer, Norwood B. Melcher, and W. O. Philbrook.*

USBM IC 8019. "Use of High-Expansion Foam on a Pennsylvania Coal-Mine Fire," by T. J. McDonald.*

USBM RI 5731. "Carbonizing Properties of Wyoming Coals," by W. S. Landers, V. F. Parry, Manuel Gomez, E. O. Wagner, J. B. Goodman, and C. R. Nelson.*

USBM RI 5698. "Fine-Screening of Coal: Testing of the Sieve Bend," by M. R. Geer, A. W. Deurbrouck, and H. F. Yancey.*

USBM RI 5708. "Design Criteria for Portable Seismographs," by Wilbur I. Duvall.*

USBM IC 8011. "Uranium Mining in the Lukachukai Mountains, Apache County, Ariz., Kerr-McGee Oil Industries, Inc.," by W. L. Dare.*

*** Available from Publications Distribution Section, Bureau of Mines, 4800 Forbes Ave., Pittsburgh 13, Pa.**

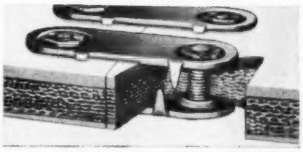
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(PHOTO TAKEN AT PEABODY COAL CO., MINE #10, PAWNEE, ILL.)

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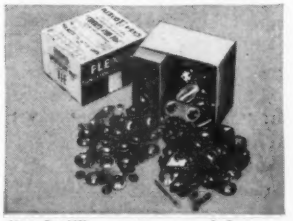
Cutaway of a Flexco application showing the compression plates, teeth and precision-made bolts and nuts.

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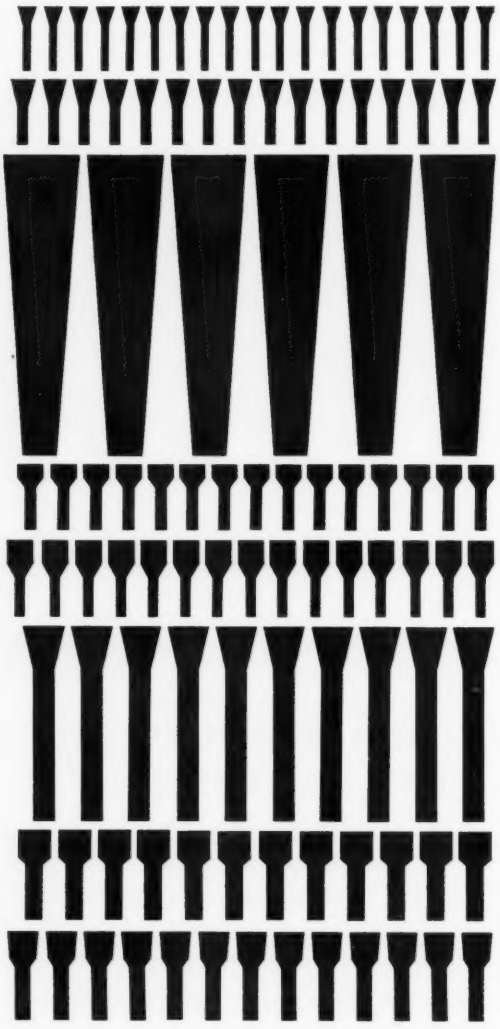
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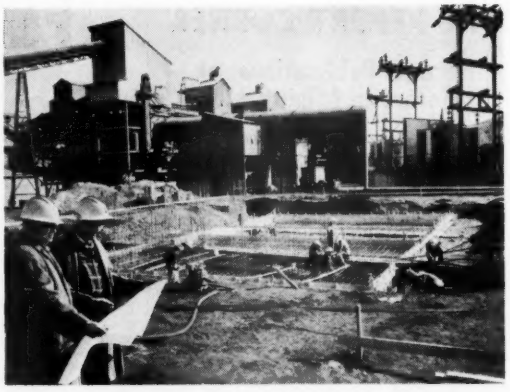


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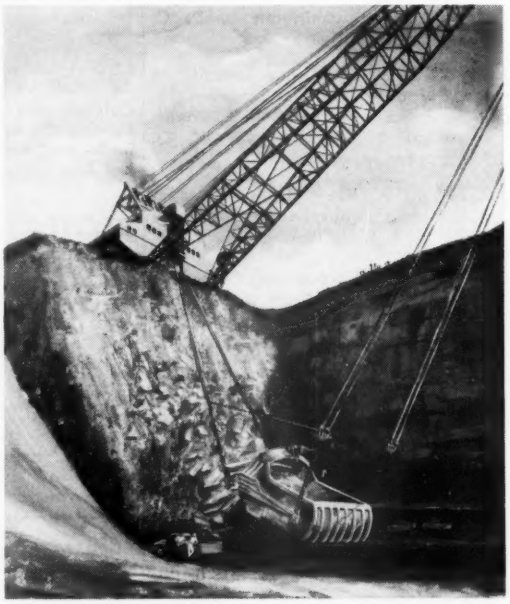


N. J. Zinc Breaks Ground for Electric Furnace

The New Jersey Zinc Co. recently announced that work has started on the construction of its new Sterling electric furnace project at Palmerton, Pa., which will insure adequate supplies of the iron-manganese alloy, spiegeleisen, to meet demands of the steel and foundry industries. This new application of electric smelting was developed by the company to treat iron-manganese ores, particularly those from its Sterling mine at Ogdensburg, N. J. The project is scheduled for completion in 1962.

Peabody's 85-Yd Dragline

The 85-yd dragline that Peabody Coal Co. has purchased from Marion Power Shovel Co. (MCJ, April 1961, p. 100) is scheduled for delivery in the latter part of 1962. To be the largest dragline ever built, the Marion Power Type 8800 will have a 275-ft boom, a working weight of over 5100 tons, and a lifting capacity of 443,000 lb. By comparison, the Marion Type 7800, one



of today's largest draglines, carries a 220-ft boom, a 35-yd bucket and has a working weight of 1725 tons. From an operating standpoint the Type 8800 machine can dig material 12 stories below ground level, swing it over 550 ft and dump it on top of a 14-story building.

It will have a swing speed of 1.6 rpm and a cycle time of approximately one minute. One operator will control all digging and walking operations.

The data below illustrate the size and power of this new giant:

Height from ground level to gantry	**100 ft**
Width, shoe to shoe	**113 ft**
Length of house	**103 ft**
Maximum height, pit floor to boom point	**324 ft**
Diameter of base	**80 ft**
Total horsepower (30 motors)	**19,830**
Dumping radius	**248 ft**

ALSO . . .

Kaiser Bauxite Co. and Reynolds Jamaica Mines, a subsidiary of Reynolds Metals Co., have been awarded contracts to supply the U. S. Government with bauxite from Jamaica for stockpiling. Kaiser will supply 400,000 tons and Reynolds 600,000 tons, bringing the total to 1,000,000 tons to be supplied during the next six months. Contracts have been signed on a barter agreement and will be paid for in surplus agricultural goods.

Island Creek Coal Co. has announced that the construction of its new plant at Red Jacket, W. Va., to manufacture stoker char from bituminous coal will be completed this spring. The stoker char will serve a growing need in the chemical industry in the production of plastics and other items.

A cooperative experimental project in Muhlenberg County, Ky., aimed at reclaiming strip mine land through reforestation, will be put into effect soon by the Department of Conservation, Tennessee Valley Authority, and Peabody Coal Co. The experiment, to be carried out on eight 10-acre plots, is designed to test the feasibility of reforesting these strip mine spoil banks for productive use through close spacing of high quality, nursery-grown pine seedlings.

At a National Coal Association reception honoring George A. Lamb, new director of the Office of Coal Research, are, left to right: Lamb; Representative John P. Saylor of Pennsylvania; Representative Wayne N. Aspinall of Colorado; Julian Conover, executive vice



president of the American Mining Congress; and Stephen F. Dunn, NCA president. Saylor was the sponsor of the bill creating the Office of Coal Research; Aspinall is chairman of the House Committee on Interior and Insular Affairs.

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The unique double expansion feature of all Pattin expansion shells insures *dependable* roof support, in hard or soft roof conditions. Their double holding power guards against failure — even under a 20 ton pull!

Pattin features include a parallel contact with the hole, and no definite drilling depth is required, as the shell can be securely anchored at any place in the hole. They anchor solidly and will not turn while being tightened. Wedge and shell are assembled in a manner to prevent loss of parts in handling, and the bolt and shell assembly are furnished as a complete unit. Plates are bundled separately. No special nuts or ears are required on the bolts. These features make a safer roof — and a safer roof means fewer accidents, increased production, more clearance for equipment operation and better ventilation.

Pattin specializes in roof bolting —it's our business, not just a sideline! Your business is important to us, and our service engineers are always available for consultation on your roof problems—ready to give you service when you need it! WRITE OR PHONE US TODAY for complete details.



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The split-type bolt is one of the first slotted bolts, and continues to be a favorite wherever split-type bolts are used. Many mines still prefer this type. The bolt is a full 1-inch in diameter, with cut threads and furnished with hex or square nuts and various size plates and wedges.

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Pattin expansion shells are available and serviced exclusively by Colorado Fuel and Iron Corporation, Denver, Colorado. Western mining companies should contact them direct for information and consultation.

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NEWS and views



Shaft Sinking Contract Awarded

Texas Gulf Sulphur Co. has awarded a shaft-sinking and underground construction contract for development of the company's potash mine near Moab, Utah, to Harrison International of Miami, Fla. Harrison and its affiliate, Patrick Harrison and Co. of Canada, are contractors with wide experience, particularly in underground development, having sunk in excess of 500 mining shafts of which over 50 descended more than 3000 ft. A recently completed assignment in northern Manitoba involved sinking over 4000 ft of shafts and driving 30 miles of underground tunnels.

Harrison International is now assembling for shipment to Utah the equipment necessary for all underground development. The shaft will have an inside diameter of 22 ft, will be sunk over 2800 ft and is scheduled to reach the potash formation late in 1962. Some 60 to 80 employes will be needed for the shaft work.

Kerr-McGee Increases Mill Capacity with New Acquisitions

Kerr-McGee Oil Industries, Inc., through its subsidiary, Kermac Nuclear Fuels Corp., has acquired all of the capital stock of Lakeview Mining Co. and Gunnison Mining Co. The transaction involved an exchange of Kermac Nuclear stock. Both of the acquired companies have solvent extraction process uranium mills, that cost in excess of $2,000,000 each when built, and have been treating uranium ores under contract with the Atomic Energy Commission. Lakeview's present contract runs to November 30, 1963 while Gunnison's runs to December 31, 1962. Operations of Lakeview will be conducted in the name of Lakeview Division of Gunnison Mining Co. J. L. Robison will continue as general manager of Gunnison, and no changes are contemplated in the management or personnel of either company. The acquisitions are part of Kerr-McGee's plan to diversify and expand its operations in the mineral industry by acquiring strategically located chemical processing facilities.

Maybell Mill Contract Extended

Trace Elements Corp., a unit of Union Carbide Corp., and the Atomic Energy Commission have signed a new uranium concentrate purchase contract effective January 1, 1961 through December 1966 providing for Government concentrate purchases valued at $20,700,000. Trace Elements operates an ore processing plant at Maybell, Colo., that produces about 250 tons of U_3O_8 in concentrates per year. About 2,500,000 lb of U_3O_8 from eligible contractor-controlled ores are deliverable to the AEC during the life of the new contract. It also provides for treatment of eligible ores from qualified independent producers in the area, and purchase of appropriate quantities of U_3O_8 derived from milling these ores. As of January 1 of this year, the Commission had purchased from the company 1,538,142 lb of U_3O_8 in concentrate valued at about $14,800,000 since the first delivery was made by Trace Elements to the AEC in December 1957.

Copper Ore Reserves Increased

Banner Mining Co. during 1960 increased copper ore reserves at its Palo Verde property near Tucson, Ariz., by about 15,000,000 tons through core drilling operations. Total reserves amenable to open pit mining at the Palo Verde are now placed at about 58,000,000 tons by Banner. The company intends to continue its core drilling program at the property during 1961. Banner's Palo Verde ores are extensions of the Mission project ore body now under development by American Smelting & Refining Co.

MCJ Receives National Safety Council Award

The National Safety Council announces that Mining Congress Journal has won its Public Interest Award for 1960, a non-competitive award honoring exceptional service to safety by organizations in the mass communications field. Established in 1948, the Public Interest Awards are presented in recognition of leadership, initiative and originality by the mass media in the promotion of accident prevention. MCJ was one of 57 specialized magazines receiving the award.

Orphan Mine Ore Contracted to Tuba City Mill

Western Gold & Uranium, Inc. has signed a contract under which uranium ore from its Orphan mine at Grand Canyon, Ariz., will be sold to Rare Metals Corp. to the end of 1966. Rare Metals will process the ore at its Tuba City, Ariz., mill.

The contract is subject to award of a 1962 to 1966 production allocation to Western Gold by the Atomic Energy Commission and a milling contract extension through 1966 between Rare Metals and the AEC. Negotiations for both of these are in progress.

The bulk of Orphan mine ore has been delivered to the Tuba City mill since 1957. Production from the mine is currently 7000 tons per month. The new agreement between the two companies calls for installation of a carbonate leach circuit at the mill. Compared with the acid extraction process presently used, savings of about $3 per ton of ore milled can be made with carbonate leach.

New Coke Plant Will Use Utah Coal

United States Smelting Refining and Mining Co. and Victor Chemical Division of Stauffer Chemical Co. are planning to build a plant at Midvale, Utah, for converting western bituminous coal to coke. The plant is slated for completion late this year.

U. S. Smelting has been experimenting with a retort process in which pelletized Utah coal is used to produce a coke that is suitable for electrometallurgical and electrochemical applications. Pellets, which are formed employing a bentonitic binder, are retorted with natural gas at 1200°C. Byproducts of the process are a gas containing 80 percent hydrogen and about 50 gal of coal oil per ton of coal.

Coal for the new plant will come from the Hiawatha mine of U. S. Smelting's subsidiary, United States Fuel Co., near Price, Utah. Production from the coke plant will be used by Victor in its elemental phosphorus plant at Silver Bow, Mont.

ALSO . . .

A lease has been taken on the Ima tungsten properties of Bradley Mining Co. near Challis, Idaho, by American Metal Climax, Inc. Bradley operated the mine from 1945 to 1947.

A reorganization in the Source Materials Procurement Division of the Atomic Energy Commission's Grand Junction, Colo., Operations Office has combined the former Concentrate Procurement Branch with the Procurement Services Branch to form the Concentrate Procurement Services Branch.

Operations of Kennecott Copper Corp. in Arizona, Nevada, Utah and New Mexico have returned to a seven-day work schedule. A six-day schedule had been in effect since February 1 in order to cut about 4500 tons per month from a copper production rate of 34,000 tons at these properties.

Underground mines of American Smelting & Refining Co. in the Coeur d'Alene mining district of Idaho are equipped with discarded refrigerators that make good storage places for first aid equipment or flammable material. They can be easily cleaned and the seal keeps out humid mine atmosphere. Contents are kept dry by installing a small light bulb. The company obtained the used refrigerators from local appliance dealers.

1961 AMC CONVENTION

Industry Leaders Developing Program for September 10-14 Meeting

National Program Committee Chairman Joseph C. Kieffer, manager, Northwestern Mining Division, American Smelting & Refining Co., announces that 20 of the country's leading mining men are serving as State and District Chairmen of the 1961 Metal Mining-Industrial Minerals Convention of the American Mining Congress. These officials are already working with men in their respective areas developing ideas for consideration at a mid-June meeting of the State Chairmen.

These ideas will be boiled down into a hard-hitting program that will bring the best qualified speakers to Seattle to cover the subjects of greatest interest. The convention will give miners the opportunity to hear authoritative and timely reports on operating and management problems, and on a wide range of Government policies that vitally concern the industry.

At the sessions in Seattle, attention will be given to national minerals policies, import problems, taxation, labor relations, public lands problems, monetary policies, and the outlook for various metals and minerals. Operating sessions will cover underground and open pit mining practices, minerals beneficiation, exploration and geology, safety, management problems and other technical subjects.

The Convention will truly be an "educational forum"—giving mining men valuable information to help them cope with the problems that lie ahead. It will bring together the best minds in the industry—and every mining man owes it to himself to be on hand and take part in the discussions.

Quite apart from industry matters—but an important and enjoyable part of every AMC Convention—are the good times in store for convention-goers. A reception on Sunday will mark the beginning of the week's activities. The tempo will pick up with a Welcoming Luncheon and a "Potlatch" on Monday and will reach a climax Wednesday evening with the "Speechless Banquet."

An interesting program is being arranged for the ladies, who will want to be on hand to renew acquaintances, make new friends, and enjoy the scenic Pacific Northwest.

Fishermen will test their skill at landing the "big ones" in the Salmon Derby planned for early Tuesday and Wednesday mornings. The person catching the biggest salmon each day will be given a prize for his achievement.

On Thursday, trips will be the order of the day, with many wishing to take in the restful boat trip to picturesque Victoria, capital of British Columbia. Others will visit Bethlehem Steel Corporation's steel mill or the Boeing plant at Seattle, while still others will take the scenic trip to beautiful Mt. Rainier National Park.

Now is the time to make plans to attend! Reservation requests are being handled by the AMC Housing Bureau, Seattle Convention and Tourist Bureau, 215 Columbia St., Seattle 4, Wash. Processing of applications is under way—first assignments will be sent out early in July.

PROGRAM COMMITTEE

National Chairman: *J. C. Kieffer*, Mgr., Northwestern Mining Dept., American Smelting & Refining Co.

STATE CHAIRMEN

Alaska: *James A. Williams*, Director, Division of Mines & Minerals
Arizona: *J. B. Pullen*, Asst. Gen. Mgr., Phelps Dodge Corp.
California: *A. M. Wilson*, Vice Pres., Utah Construction & Mining Co.
Colorado: *Robert Henderson*, Vice Pres., Western Operations, Climax Molybdenum Co.
Idaho: *Charles E. Schwab*, Pres., The Bunker Hill Co.
Montana: *John Bley*, Vice Pres. & Gen. Mgr., American Chrome Co.
Nevada: *Robert O. Jones*, Mgr., Western Division, The Standard Slag Co.
New Mexico: *Earl H. Miller*, Resident Mgr., U. S. Borax & Chemical Corp.
Oregon: *Frank E. McCaslin*, Pres., Oregon Portland Cement Co.
South Dakota: *A. H. Shoemaker*, Vice Pres. & Gen. Mgr., Homestake Mining Co.
Texas: *Claude O. Stephens*, Pres., Texas Gulf Sulphur Co.
Utah: *J. P. O'Keefe*, Gen. Mgr., Utah Copper Div., Kennecott Copper Corp.
Washington: *John W. Currie*, Resident Mgr., American Zinc, Lead & Smelting Co.
Wyoming: *Roy Coulson*, Div. Supt., Vitro Minerals Corp.
Lake Superior: *Carl B. Jacobs*, Vice Pres., Raw Materials, Inland Steel Co.
Missouri-Kansas-Oklahoma: *Claude O. Dale*, Vice Pres., Chemicals & Metals Div., The Eagle-Picher Co.
Eastern States: *Vincent D. Perry*, Vice Pres., The Anaconda Co.
Central States: *Carl G. Hogberg*, Pres., Michigan Limestone Division, U. S. Steel Corp.
Southern States: *Sheldon P. Wimpfen*, Exec. Asst. to Pres., Reynolds Mining Corp.
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ADV-1748

A diamond drill, said to be the world's largest, has been installed at Kalgoorie Southern Gold Mines in Australia. The drill is designed for drilling either vertical or angle holes to depths in excess of 10,000 ft. It will be used initially for drilling BX holes. This rig will operate in conjunction with an inclineable frame carrying a headsheave 72 ft from the base which permits hoisting 60 ft lengths of rods. Incorporated in the drill rig are a trunnion-mounted head, single-drum hoist designed for 50,000 lb direct line pulls, 175-hp diesel engine, control console, torque convertor and hydraulic power-shift gearbox. The rig can be operated by two men.

The lease under which American Smelting & Refining Co. has operated the Jack Waite mine located on the Idaho-Montana border is being terminated. Asarco had leased the property from Jack Waite Mining Co. since 1934 and produced about 1000 tons of ore per month from the mine which employed about 25 men.

Work is underway to reopen the Wellington lead-zinc mine near Breckenridge, Colo. Consolidated Parnett Corp. is operator of the mine and general partner in the Wellington Mine Association, a limited partnership which holds leases on the Wellington properties and owns a large block of surrounding claims. Operations presently underway are aimed at cleaning up and rehabilitating the old workings and access ways. The company plans to sink a winze and drive a crosscut at a new level 230 ft below the present tunnel. Future plans call for the installation of a 150 ton flotation mill at the mine portal.

Exploration by the metallurgical and chemical division of the Susquehanna Corp. near Sante Fe, N. M., has initially revealed the occurrence of germanium, copper and uranium. The company indicates that the germanium is present in substantial quantities and that its early exploration work is promising. Susquehanna recently began operating its Falls City, Texas, uranium ore processing plant, which has a rated capacity of about 300 tpd.

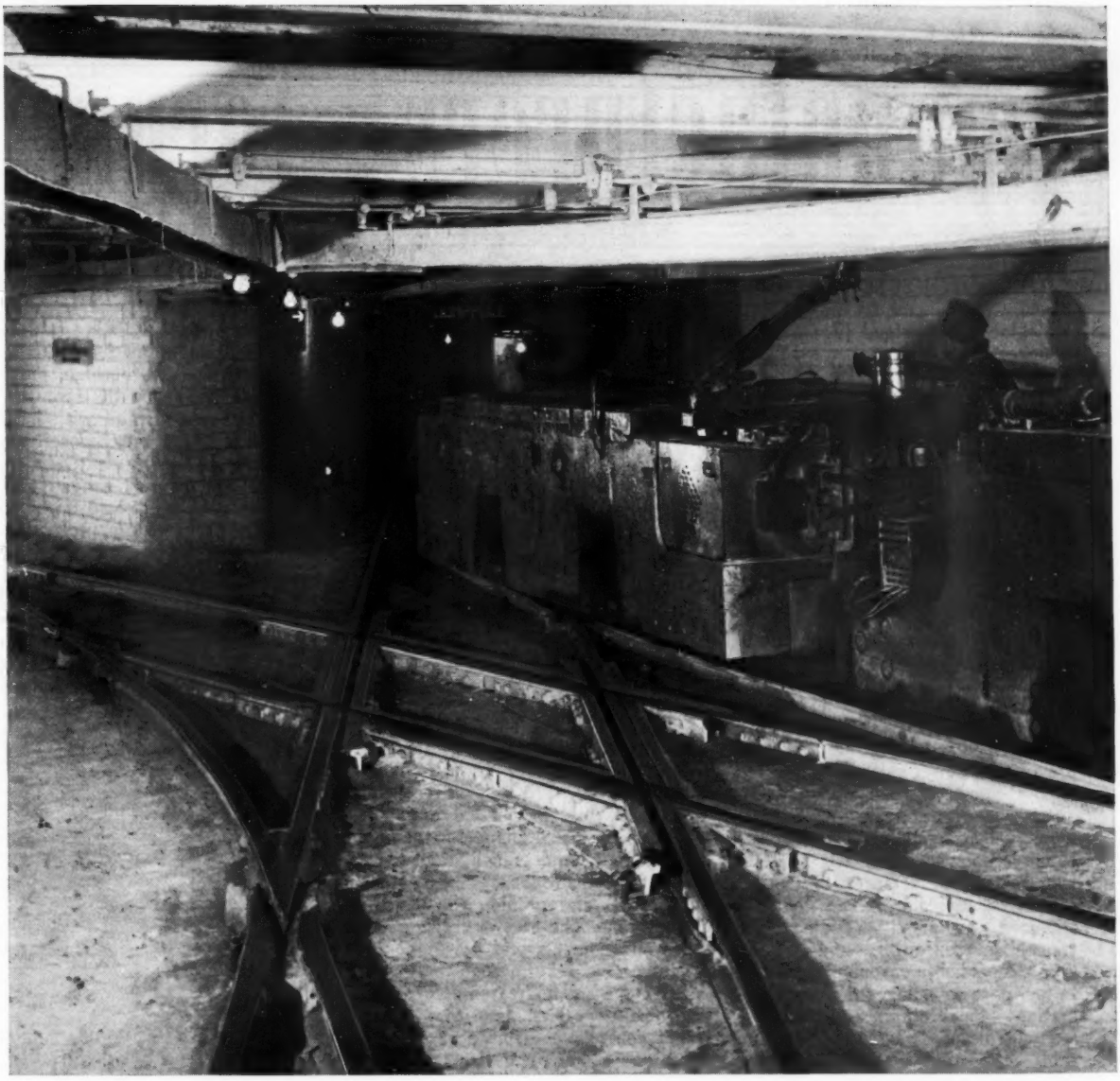
Hanna Mining Co. has acquired the Government-owned nickel smelter at Riddle, Ore., and plans to produce ferronickel (45 percent Ni) for the commercial market. Since 1955, the company has smelted ore for the account of the defense materials stockpile. The Ugine process, which was developed for refining chrome, is used by Hanna for electric-furnace smelting of nickel ore from its nearby mine. The Riddle plant produced about 22,000,000 lb of ferronickel in 1960.

Fifty-thousand tons of iron ore per month will be mined from a deposit near Parker, Arizona, according to plans of Golden Gate Mining Co. The company recently signed a 10 year contract with Fred Rood Co. of Little Rock, Ark., under terms of which Rood will build a crushing plant at the mine site. Ore from the mine will be exported with much of it going to Japan. Golden Gate proposes to begin construction on a steel plant in the area later this year.

Magma Copper Co. is reported to have taken a 15-year option on 120 unpatented and 12 patented mining claims of Belmont Mining Co. at Superior, Arizona. The properties are contiguous with 50 claims that Magma took an option on in 1958.



Installing the final bolt in a cast-iron shaft lining that walls off a 200 ft layer of quicksand at the International Minerals Chemical Corp. (Canada) potash project at Esterhazy, Saskatchewan, are the Province's Premier T. C. Douglas (right) and IMC President Thomas M. Ware. The bolt is the last of some 17,000 used to assemble a 3000-ton shaft lining that passes through a water-bearing layer of the Blairmore sandstone which had been blocking development of what has been called the largest deposit of high-grade potash ore in the world. IMC expects to have its mine and plant in production within the next 15 months.



Where your operating requirements call for a complicated layout like this, you'll value the extras you get in the "Bethlehem approach." And in the long run, Bethlehem-designed and prefabricated trackwork costs less than the do-it-yourself kind.

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To begin with, one of our engineers will visit your workings. There he will absorb all you tell him about your operations, both present and proposed. Then he'll return to Bethlehem and huddle with our mine-track specialists. Plans will be drawn up for your approval.

Next, all rail material will be prepared including precutting, curving, and match-marking against the plans. All components will be assembled on our layout floors to be sure of perfect fitting. When the order arrives at your site, everything will fit smoothly into place without waste or worry.

This is the way to be sure you're on the right track. And this is the way more and more mines are improving their haulage systems, and lowering operating costs. We're ready to start working with you right now. A phone call or note will start things moving.

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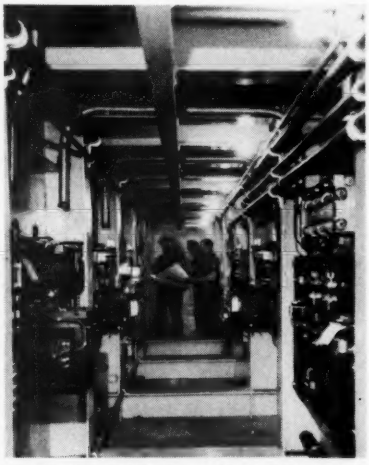
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manufacturers forum

THE SIX-WHEEL SCRAPER, Model SS-40, which Euclid, Division of General Motors, Cleveland 17, Ohio, announces as its largest, has a 125,000 lb payload capacity and a 40 cu yd struck capacity. Designed for high production jobs, with long, high speed hauls at speeds up to 34 mph, the



SS-40 is powered by a GM 12-cylinder diesel engine (12V-71) of 432 hp. It is equipped with an Allison Torqmatic Drive having four forward and two reverse speed ranges that provide full power shift. Incorporated in the converter-transmission package is a converter lock-up for maximum fuel economy and efficient use of engine power. Torqmatic brake, a hydraulic speed retarder to control speeds on long downgrade hauls, is standard equipment. Engine and transmission oil filters, and the dry type cleaners are conveniently located to facilitate servicing. All scraper operations—bowl, apron, and ejector—are completely hydraulic with no cable connections.



OVERHEAD TRAVELING CRANES, manufactured by Harnischfeger Corp., 4444 W. National Ave., Milwaukee 46, Wis., have recently undergone what is claimed to be a most radical design change, including a pressurized and well-lighted passageway (shown above) inside the main girder and running the length of the crane. The area is utilized for electronic controls and power components. This feature reportedly reduces costs and increases safety for maintenance crews. Improved electronic controls contribute to better speed and power regulation.

AN INDUSTRIAL FIRST AID KIT available in four different sizes for various size groups is being sold by the Safety Products Division of American Optical Co., Southbridge, Mass. Designed to enable on-the-spot first aid, the kits are marked with large blaze orange letters on charcoal gray cases for quick, easy identification. They are made of 20-gauge steel, have reinforced electrically welded joints to offer maximum protection, have snugly fitting lids, and keep out water and moisture through the use of a special rubber gasket. Wall brackets, carrying handles and snap locks are built into each case which contain such items as compresses, bandages, iodine swabs, tourniquets, inhalants and burn salves.



A PORTABLE SAMPLE SPLITTER, which halves and quarters samples of about ½ cu ft in sizes from sand up to two-in. aggregates, has been announced by Gilson Screen Co., Malinta, Ohio. Though smaller than the model released two years ago, the Gilson Porta Splitter retains the important features of its larger companion. Chief of these features are a loading hopper that permits hand levelling of the sample to be divided, and an adjustable universal splitter chute which provides quick and accurate selection of a variety of chute openings. The equipment is made of heavy welded steel, and is small enough for convenient transport in an automobile trunk.

A 55-TON REAR DUMP TRAILER with variable wheel base has been designed by Easton Car & Construction Co., Easton, Pa. The vehicle, entitled the TS-3755, augments the established Easton line which includes similar trailers in capacities of 22 and 35 tons, and it is adaptable for use with any suitable two-axle tractor. The TS-3755 will be built to order only, because the overall dimensions of the trailer and the design of the draft beam for the universal hitch will vary according to the tractor.



—ANNOUNCEMENTS—

Alfred E. "Red Necktie" Pickard has announced that he is retiring, for health reasons, from full participation in the business of **Pickard Industries, Inc.** He has been associated with the mining industry for 35 years and is president of Pickard Industries. His wife, who has been active in the affairs of the company ever since it was started, will take over control of the business with the assistance of **Ernest Reynolds.**



Paul E. Kluttig, manager of pipe and tube sales since 1953 for **Phelps Dodge Products Corp.,** New York, has been elected assistant vice president of the company. Kluttig has been associated with the nonferrous metals industry for many years and was at one time with the American Brass Co., and with Phosphor Bronze Corp.

J. L. Vint, Jr., president of **Unit Rig & Equipment Co.,** Tulsa, Okla., has just been elected to a directorship in the company.

LeTourneau-Westinghouse Co., Peoria, Ill., has appointed **George D. Leigh** product manager, Trucks. Leigh comes to LW after 10 years with Utah Construction and Mining Co. He served as a staff member of management in the Operations Engineering Department for the Mining Division at Cedar City, Utah, and has a varied background in truck operations in open pit and iron ore mining.



Donald F. Blake, formerly advertising and publicity manager for the Connors Steel Division of **H. K. Porter Co.,** Inc., at Birmingham Ala., has been appointed advertising manager with headquarters in Pittsburgh. His responsibilities will include coordination of trade show exhibits and direct mail advertising.

Blake will be succeeded by **C. Stanley Dalton** who will direct advertising public relations and sales promotion for both the Birmingham and the Huntington, W. Va., plants of Connors Steel.

WEMCO, a division of **Western Machinery Co.,** San Francisco, has announced the formation of two new departments. **William H. Newton** will direct the Projects Department, which will specialize in the design, engineering and installation of



W. H. Newton



F. V. Schneider

WEMCO equipment "packages" and "processing systems" for the mineral and coal and other processing industries, while **F. V. Schneider** will head the Processing Equipment Department, which will be responsible for sales and development of WEMCO equipment for these same industries.

Canadian Aero Service Ltd., Ottowa, Canada, has formed a Toronto subsidiary, **Canadian Aero Mineral Surveys Ltd.,** to provide broader airborne and ground geophysical facilities to the mining exploration field. The new company will be under the direction of **Donald M. Wagg,** formerly chief geophysicist of Rio Tinto Mining Co., in Canada.

Jerome J. Lawson has been appointed manager of advertising and promotion of the Organic Chemicals Div., **American Cyanamid Co.,** and will maintain offices in New York and in Bound Brook, N. J., where he will direct the advertising and promotion of mining chemicals, explosives, petrochemicals and other products.

Sheldon Jones of Huntington, W. Va., for twenty-one years associated with the mining industry in both mining operation and sales to mining companies, has been appointed by **Goodman Mfg. Co.** as assistant manager of its Huntington sales district.



CATALOGS & BULLETINS

PORTABLE TESTING SCREEN. *Dept. NR, Gilson Screen Co., 110 Center St., Malinta, Ohio.* The company has announced new accessories and equipment for use with Gilson Porta-Screen, a portable testing screen for test sizing of aggregates in a size range from 2 in. to 325 mesh. New equipment includes provision for a "scalping" operation when separation of test samples into more than six segments is required. For transporting the screen without disassembly, new Porta Wheels—rubber-tired, ball bearing wheels—are now available.

SINTER ANALYSIS. *Philips Electronic Instruments, 750 S. Fulton Ave., Mt. Vernon, N. Y.* Two-page bulletin describes how U. S. Steel Corp. controls sinter quality with an electronic instrument called an Autrometer, and gives details on the speedy routine which now handles 18–30 sinter samples and 6–12 ore samples daily. It discusses quantitative determinations which are made on six elements of 25 minutes. Specimen preparation is also described.

ORE PHOTOMICROGRAPHS. *Dr. Friedemann F. H. Freund, 919 West Fairmount Ave., State College, Pa.* Catalog describes the Card Index of Ore Photomicrographs, which reportedly will cover the entire field of ore microscopy. All of the important known opaque minerals will be included, and all characteristic paragenesis will be presented. The card index is in the form of individual cards which may be subscribed in its entirety, subscribed as selected sections or subdivisions, or purchased as classroom quantities of individual cards. Published by Umschau Verlag, 20–24 Shuttgarter Strasse, Frankfurt Am Main, West Germany, this card index has set out to provide a comprehensive explanatory atlas of all the characteristic mineralogical appearances of typical ores from all over the world.

CARBIDE MINING BITS. *Carmet Div., Allegheny Ludlum Steel Corp., Wanda & Jarvis Sts., Detroit 20, Mich.* A catalogue entitled "Carmet Cemented Carbide Mining Tools" gives details on the 28 styles of carbide mining bits from the Carmet Division, including: slotted open face bits, chisel nose bits, cylindrical insert bits, and coal drill and roof drill bits. In addition, details are given on special carbide grades, mining tool identification, and detailed drawings on each of the mining tools. There is a special section on tool reconditioning.

MAGNETIC TUBE TESTER. *Dings Magnetic Separator Co., 4740 W. Electric Ave., Milwaukee 46, Wis.* Bulletin 1509-BN describes the Davis magnetic tube tester manufactured by Dings. It includes specifications and application data outlining now the laboratory unit is employed for determining magnetic media content in products obtained from dense media and cyclone processes, for analysis of ore samples during prospecting, and for determining magnetic taconite content in products obtained from magnetic separators during taconite processing. Outlined are specifications for an electromagnetic model and permanent type unit.

(Continued on next page)

(*Continued from previous page*)

SPECTROCHEMICAL EXCITATION EQUIPMENT. *Jarrell-Ash Co., 26 Farwell St., Newtonville 60, Mass.* The Spectro-Varisource is the newest member of the company's line of Varisource spectrochemical excitation equipment, and it is described in Brochure SV-12–60, which also discusses the latest discharge circuits available such as the Constant Current DC arc. The unit is said to be designed to provide sufficient power for most spectrochemical applications and it retains the precision characteristic of larger units.

GREASE GUNS. *Lincoln Engineering Co., 4010 Goodfellow Blvd., St. Louis 20, Mo.* Lincoln's 1142 and 1169 model lever guns are described in Bulletin 732. The former is set to dispense bulk grease while the latter is set to handle lube cartridges. However, by flipping the follower to the correct position either gun can handle cartridges or bulk grease. Both models feature three-way reloading (cartridge, from filler pump or by suction).

AIR-QUENCHING CLINKER. *Allis-Chalmers, Milwaukee 1, Wis.* How the Air-Quenching clinker cooler is able to recuperate more than 75 percent of sensible clinker heat and return it to a rotary kiln as highly preheated secondary air for more efficient combustion is told in Bulletin 22B7869B. Cooler features claimed in the bulletin include an undergrate pulsating damper which permits the carrying of deeper clinker beds, gives highest possible secondary air temperature, and extends grate life, and a Nucontroller device providing continuous control of clinker bed depths.

MECHANICAL CONVEYORS. *Syntron Co., 703 Lexington Ave., Homer City, Pa.* A new vibratory mechanical conveyor catalog section contains descriptions and specifications on the company's light, medium and heavy tonnage conveyors.

AIR TOOLS. *Advertising Dept., Thor Power Tool Co., 175 N. State St., Aurora, Ill.* A complete lineup of Thor air tools for mines, quarries, tunnel builders and others is listed, described and detailed in Catalog No. 46.

WELDING TORCHES. *Linde Co., Division of Union Carbide Corp., 270 Park Ave., New York 17, N. Y.* Oxweld W-45 and W-47 welding torches, covered in Form 55-005, are reportedly capable of welding any metal thickness from 28 gage sheet to heavy plate. A feature of the torches is their ability to handle gas flows as low as two cu ft per hr for precision welding, or total flows as high as 1500 cu ft per hr for heavy heating operations. Also described in the brochure are cutting attachments for converting the torches from welding and heating to flame-cutting on all metal thicknesses up to eight in. Ordering information and performance data on a complete selection of welding heads and cutting nozzles is included in the bulletin.

SCALE MAINTENANCE. *Howe Scale Co., Rutland, Vt.* The booklet discusses the most common causes of scale error and the serious cost control problems that result from these errors. It also points out the step-by-step procedure required to eliminate the dangers of scale error. Also covered are the special equipment and training needed to carry out a satisfactory scale service program and the costs involved.

ORAL RESUSCITATOR. *Mine Safety Appliances Co., 201 N. Braddock Ave., Pittsburgh 8, Pa.* Venti-Breather, an oral resuscitator that overcomes mouth-to-mouth contact in rescue breathing, is illustrated and described in Bulletin No. 1100–4. The unit consists of a mouthpiece, breather tube, one-way valve and flexible face mask.

TRUCK CRANE. *Construction and Mining Div., 4445 W. National Ave., Milwaukee 46, Wisc.* P&H Model 890-TC, said by the company to be the world's largest truck crane, is described in a 12-page technical portfolio recently released. Included is information on Harnischfeger's Magnetorque swing system and operating specifications of each front end attachment.

PRECISION SWITCHES. MICRO SWITCH, *Freeport, Ill., a division of Minneapolis-Honeywell Regulator Co.* Catalog 104 has photos and condensed descriptions of over 200 items covering a representative selection of products from the Micro-Switch line of precision switches for industrial, commercial, data processing, airborne and electronic applications.

PIPE AND TUBING MEASUREMENT. *Aeroquip Corp., Jackson, Mich.* Entitled "How to Measure and Relate Pipe, Tubing and Hose Sizes," Bulletin No. 631 supplies standard methods of measurements, discussing both the similarities and the differences involved in measuring various fittings and fluid-carrying lines in order to arrive at satisfactory fluid line installations. Also discussed are standard practices of measuring adapters and complete assemblies. The dash numbering systems commonly used in pipe and tubing measurements are explained in chart form.

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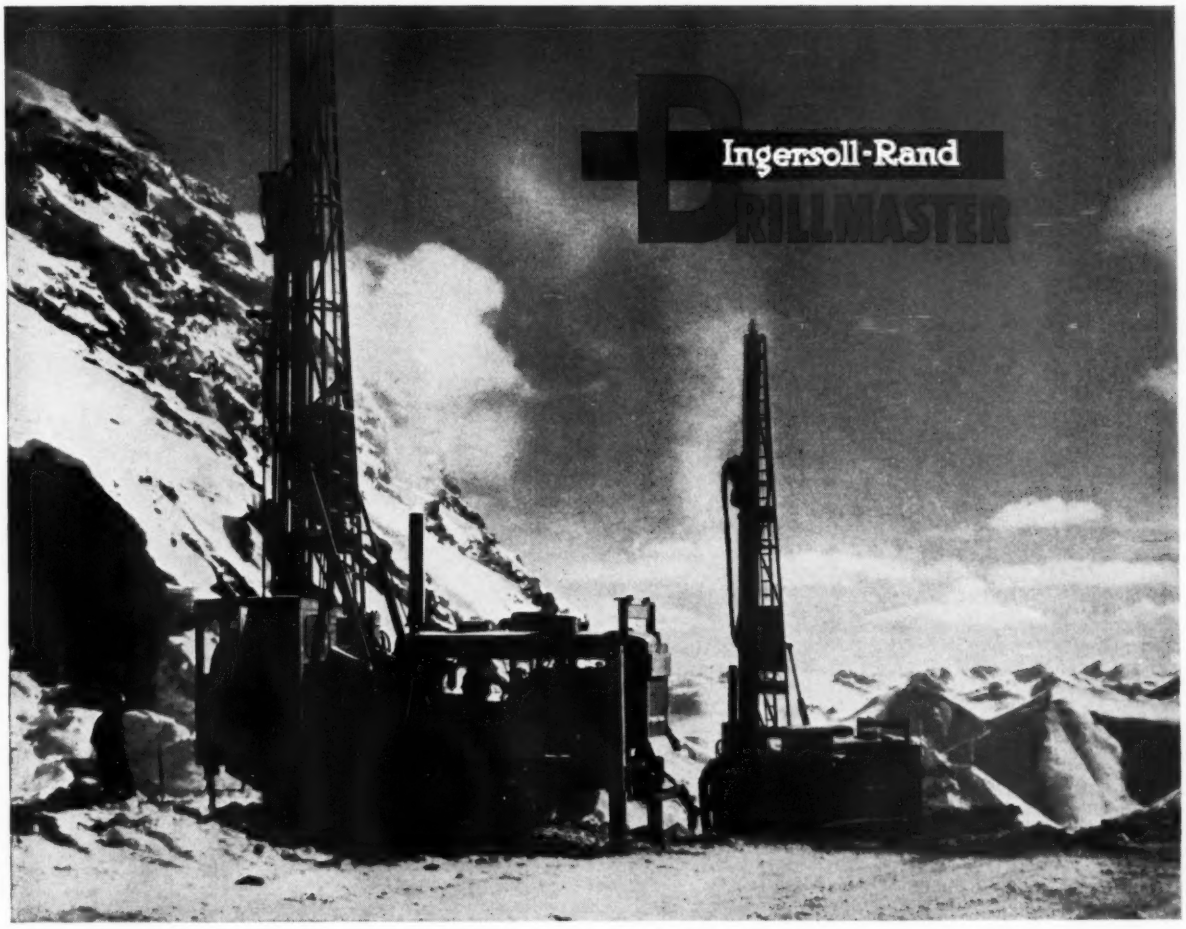
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